BIBLE NATURE SERIES

NUMBER THREE

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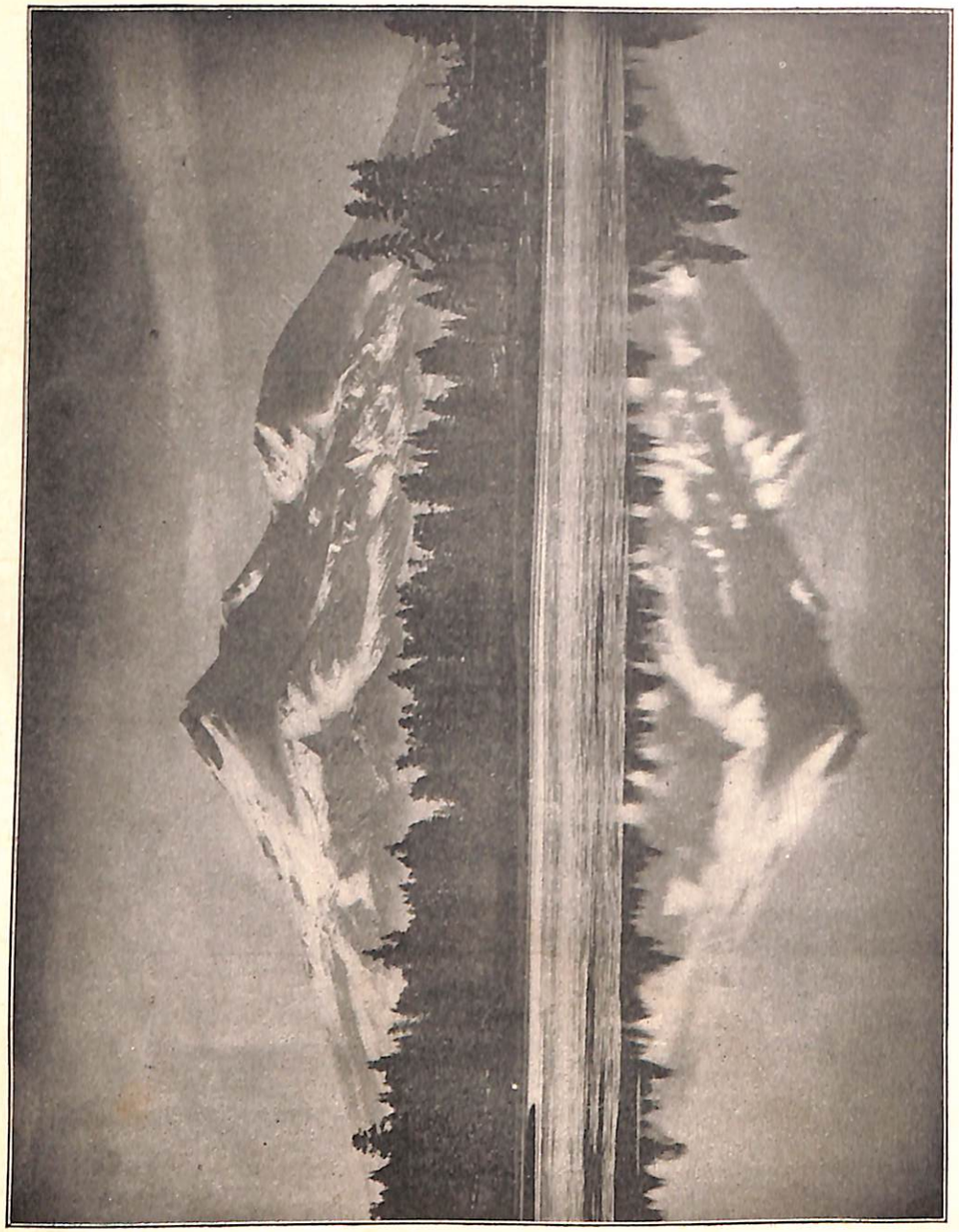

MOUNT SHASTA, CALIFORNIA

Bible Nature Series

NUMBER THREE

A Natural Development of Geography, Physiology, and the other Elementary Sciences, with the Bible and Nature as a Basis of Study

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By MARION E. CADY

Author of "Bible Nature Studies," "Nature Study Note Book," "Bible Nature Series Nos. 1 and 2," Etc.

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THE PREFACE

THE Bible Nature Series consists of three books, and is designed for use in the fourth, fifth, and sixth years of the Primary School. The endeavor has been to present, in three graded texts, elementary studies in Nature, including introductory lessons in Geography, and lessons in elementary Physiology, these lessons being so developed in the light of revelation that all creation may become to the child an expression of divine love, infinite wisdom, and eternal power.

Nature has been marred by sin, but the light shining upon it from the pages of Inspiration makes clear its mysteries. Without this light of God's perfect revelation,— the Bible record,— the facts of creation can not be rightly interpreted, nor their wonderful lessons discerned. Hence, whatever light Inspiration throws upon creation is of infinite value.

Believing that the great Master Builder proceeded to build this world in an orderly and logical manner, each step revealing plan and method in His work, the order of creation has been adopted as the order of progression in the development of the lessons in each of the three books of the Bible Nature Series. The work of creation was followed by the disobedience of our first parents, which resulted in bringing death and destruction into the fair creation. But God has provided a plan to redeem man,— the plan of redemption. So, following the lessons on creation, briefly and simply are developed lessons giving the story of redemption from Adam's fall until he shall take his place again in Eden — the Eden restored.

It is upon this plan that each of the three books of this series has been constructed. It is not designed that there shall be a jumping from topic to topic, but that, in the logical order of the creation sequence, such a natural advance shall be maintained as shall tend to develop in the pupil's mind a need for the next topic to be presented. Thus it is believed that a unity and

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a mutual dependence of the several years of study in all elementary science work may be laid in the Primary School upon the completion of the sixth year.

Following the lessons in nature work, the student is prepared for an introduction to the elementary sciences as separate studies. Having been introduced in the Bible Nature Series to the subject of Geography, and having mastered all of that subject that is usually included in a primary Geography, he should now be able to complete an advanced Geography in the seventh year. Likewise a text in Physiology is now needed, and may be completed in the eighth year.

It is confidently believed that the work in Bible Nature Study, Geography, and Physiology provided for the Primary Schools will lay an excellent foundation for all further study of the sciences in both Intermediate and Training Schools.

But best of all will be the ability gained by the pupil to discriminate between truth and error. He will have learned how to use the unerring standard — the Bible — in the study of creation, and to reject all that is "science falsely so called," whose fruit is infidelity and skepticism.

Special Features.— To accompany the text, Note Books have been prepared for the pupil's use. These are profusely illustrated with appropriate and beautiful pen drawings. These Note Books, in the hands of the pupils, will greatly aid the teacher in carrying on the Nature Study work. Nature Study Drawing and Note Book No. 3 is designed to accompany No. 3 of the Bible Nature Series, and the Note Book Requirements suggested in connection with the lessons in the text may be executed in that book. Thus is the pupil encouraged to give back to the teacher in drawings and compositions what he has received in study and in recitation. In this way, work is provided for the hand as well as for the head, and facts are more deeply impressed upon the memory by means of reproduction.

Especially are the Skeleton Outline Maps accompanying the Note Books valuable as a means of making graphic the facts of

the text, and impressing not only physical and political outlines, but especially the principles of Physical Geography, which are largely responsible for the industrial and political conditions of to-day. The repeated lettering of names upon these skeleton maps is an effective device for teaching Spelling, as, upon correct outline maps, the pupil is requested to show the physical and political features of the hemispheres and continents studied.

The Note Book Requirements are by no means intended to be arbitrary, but only suggestive. Many teachers may wish to make their own requirements. Others will be able to supplement those given, and adapt them to the needs of their particular classes.

A general treatment of certain subjects has been necessary in order to make such study possible for all children in all localities. By suggestive questions, however, an effort has been made to localize such topics for the individual pupil. The child should be encouraged to study his own environment, and to explain its life and conditions by the universal facts presented in the text.

Illustrations.— The illustrations have been chosen, not for their value as mere pictures, but for their teaching and illustrative value. These have been largely selected from private collections, although many drawings have been made especially for the text.

The lessons in the Bible Nature Series are the result of simplifying and properly grading the subject-matter contained in "Bible Nature Studies." These lessons have been adapted for use by being worked out in the schoolroom, with children in the grades for which the books are designed. This work has been done by Miss Katherine B. Hale, director of the Walla Walla College Normal Department, a teacher eminently fitted both by education and by experience to accomplish this task successfully.

Helpful suggestions and criticisms will be welcomed by the author.

M. E. CADY.

College Place, Wash., March 15, 1913.

Suggestions to Teachers

The following are a few points that the teachers should constantly emphasize in teaching the Bible Nature lessons:—

1. The Bible is the only unquestionable source of authority in the study of God's created works. Develop in your pupils an intelligent, living faith in the word of God.

2. From the known to the unknown, from the earthly to the heavenly, from the natural to the spiritual, is the divine method in teaching, as illustrated by the Great Teacher in the parables He uttered. If you stop short of the spiritual, your pupils will suffer an irreparable loss. You have fed them husks and shucks, but no kernel, no meat.

3. As far as possible, teach directly from nature. If you can not go out to it with your pupils, then if possible bring it to them. Put yourself out to provide the materials necessary for illustrating the lessons. "Nature is a living, healthful teacher."

4. Have your pupils give back to you what you have given to them. This they can do orally, by drawings, and by compositions. What the pupils give back to the teacher they know, but what you give to them they may not comprehend. Test their knowledge frequently. Insist on definiteness and accuracy of expression, whether oral or written. Clear statements, correct spelling, legible writing, good drawing, are important elements in an education, and can be wonderfully developed in the Bible Nature classes.

5. Do not allow your pupils to use words or scientific terms which they can not correctly spell and define. Have frequent spelling and definition tests, and take these into account in giving credits of standing.

6. The knowledge of creation is the knowledge of the Creator. His knowledge and wisdom are expressed in the things of nature. Impress upon the pupils that they are thinking the thoughts of God as they study and contemplate His works. Creation and redemption will be the ever-delighting and never-ending themes of study throughout the years of eternity. Impress upon the pupils that in the Bible Nature lessons they begin a study which, if rightly carried forward, will never end, and that a righteous character is the only passport that will insure admission to the heavenly school.

M. E. C.

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CHAPTER I

IN THE BEGINNING

(Scripture Basis, Gen. 1:1, 2)

"Darkness was upon the face of the deep."

Lesson I

The Worlds

Through faith we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear. Heb. 11:3.

Man was not present on creation's first glorious morning, for he himself had not yet been created. God said to Job, "Where wast thou when I laid the foundations of the earth? declare, if thou hast understanding." This is a very appropriate question, and might have been asked of Adam as well as of Job. It may be very appropriately asked also of the very wisest men on earth to-day.

Since man did not see God create the earth, the only way he can learn how it was created is through revelation.

Some of the ancients, without a knowledge of God's revelation, had various ideas concerning the origin and history of our earth. Even at the present time there are those who are devoting much time to the study of earth's history; but without the aid of revelation, the best they can do is to speculate, and therefore many of their theories are little more than guesses.

When we attempt to read from nature only, earth's study is very difficult, and we become confused; but when we read the record given us through revelation, we are better able to understand the secrets that all nature holds for our study.

The Bible teaches us that God created the *worlds*, and it also tells us *how* He created them. "By the word of the Lord were the heavens made; and all the *host* of them by the breath of His mouth. . . . For He *spake*, and it was done; He *commanded*, and it stood fast." Worlds were created by His "word," by the "breath of His mouth." God spoke, He commanded; and not only this world, but a *host* of worlds, came into existence. We know that God has created many worlds besides the one on which we live. We are told, "The worlds were framed by the word of God." In one place, speaking of Christ, Paul says, "By whom also He made the *worlds*." Not one world is here spoken of, but many worlds.

We need only look at the heavens on some clear night to be convinced that there is a countless host of heavenly bodies in God's great universe, and the telescope reveals many more that we can not see with the naked eye. Immense numbers of stars invisible to the eye, even with the aid of the telescope. have been discovered by photography.

We have learned from the Bible that God is the Creator. He Himself declares that beside Him there is none else. "I am the Lord, and there is none else, there is no God beside Me. . . . I have made the earth, and created man upon it: I, even My hands, have stretched out the heavens, and all their *host* have I commanded."

Questions

1. What can you say of the origin of our planet?
2. Why did many of the ancients not understand the origin and history of the earth?
3. Is it wise to study nature without reference to revelation?

Note Book Requirement

Copy Heb. 11:3 and Isa. 45:5, 12, upon page 5 of Nature Study Note Book No. 3.

"UPHOLDING ALL THINGS BY THE WORD OF HIS POWER"

Lesson II

How the Worlds Are Upheld

He stretcheth out the north over the empty place, and hangeth the earth upon nothing. Job 26:7.

Lift up your eyes on high, and behold who hath created these things, that bringeth out their host by number: He calleth them all by names

by the greatness of His might, for that He is strong in power; not one faileth. Isa. 40: 26.

It is known that the earth is a great spherical body, with an equatorial diameter of about 8,000 miles, and a circumference of about 25,000 miles. It is also known that our earth is but one of a family of heavenly bodies, some smaller, some larger, that journey in space about a central member, the sun.

It is known that these and other shining orbs above us are of great size, and that it is because of their immense distances from us that they appear as mere specks of light. The diameter of the sun is nearly one hundred ten times that of the earth, and many of the bright stars above us are hundreds of times as great as the sun.

You have learned that these heavenly bodies are in motion, and that each moves in its appointed path. Yet there are millions and millions of worlds speeding through space. Is not this marvelous? By what means are all these worlds upheld in space?

What has the Creator been doing since finishing the work of creating these worlds? Has He been resting, or has He been working? Now we know that God does not tire when He works. "Hast thou not known? hast thou not heard, that the everlasting God, the Lord, the Creator of the ends of the earth, fainteth not, neither is weary?" Christ, the Son of God, surely can tell us just what His Father has been doing. He says, "My Father worketh hitherto, and I work."

We have been told to lift up our eyes and behold the power of God in the movements of the stars. He holds them in their courses, and because He is strong in power, not one fails. We can not understand how the worlds are upheld, how they are kept in their appointed paths, and how they are prevented from clashing one against another, but we know it is true. It is the power of the Creator that brings forth their mighty hosts by number. To each, He has given its name. "He telleth the number of the stars; He calleth them all by their names."

Thus after God and His Son had finished the work of creating this world, They continued to exercise Their power by upholding that which had been created, and are even yet "upholding all things by the word of His power." "He is before all things, and by Him all things consist." The word "consist" means "to hold together." Were it not for the power of God which upholds the worlds, and holds things together, this world would not be. The earth is not propped up by pillars, or carried on the backs of elephants that stand on a huge turtle, as some of the ancients supposed. Why did they have such foolish notions? — Because they did not study and believe God's word.

Questions

1. Describe the earth as to size and shape.
2. Can you find anything in the Scriptures upon either of these points? Isa. 40: 15, 22.
3. What have you previously learned of the solar system?
4. Do you think there is any limit to God's power? Is there anything too difficult for Him to do? Ps. 147: 4, 5.
5. What nightly exhibition have we of God's power? Isa. 40: 26; Ps. 19: 1, 2.

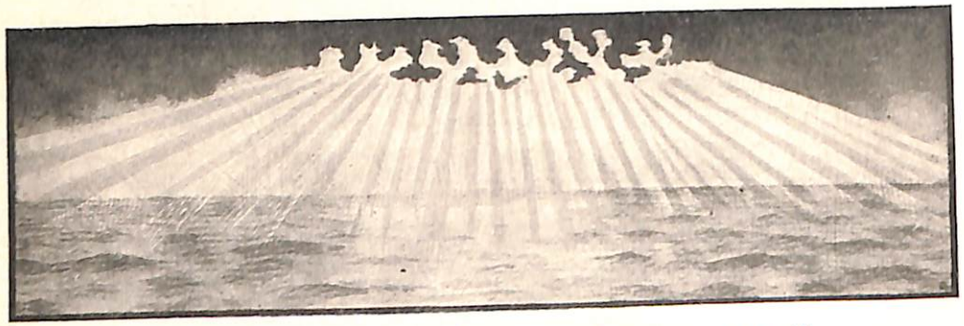
Note Book Requirement

Upon page 6 explain the motions of our planet and tell how it is guided in its path in space.

CHAPTER II

LIGHT AND HEAT

(Scripture Basis, Gen. 1:3-5)



"And God said, Let there be light: and there was light."

Lesson III

Light and Its Habits

Whatsoever doth make manifest is light. Eph. 5:13.

The use of light is to illumine or reveal. The Scriptures give us a broader definition of light than man has yet given in any book of science. The more we study this definition, the more complete it will seem. "Whatsoever doth make manifest"— that is, make plain or clearly reveal —"is light." Let us now review some of the facts previously studied about natural or physical light,— the light that is received by our natural eyes. What do you already know about light? Are you able to tell something of its habits?

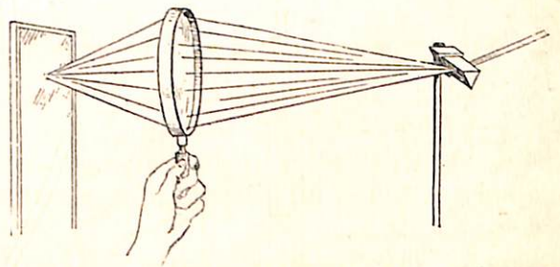
First of all, *light travels.* Just how it travels we do not know, but we do know something about the *direction* it takes

while traveling. You notice that it travels in a straight line from where the beam enters the room to the floor. If light did not travel in straight lines, we could have no shade. The light would bend under the branches of the trees, and peek around the corners of our homes, and man and the lower animals would constantly be in the blazing light of the sun.

Light has color. Scientists tell us that it is white, and this agrees with the Scriptures: "His [Christ's] face did shine as the sun, and His raiment was *white* as the *light.*" When Christ was glorified, to look into His face was like looking into the sun. Perhaps this is one reason why Jesus is called the "Sun of Righteousness." The sunbeam is white. But we find that a beam of white light passed through a glass prism divides into seven colors,— violet, indigo, blue, green, yellow, orange, and red. On passing these colors through a reading glass we find that the light again appears white.

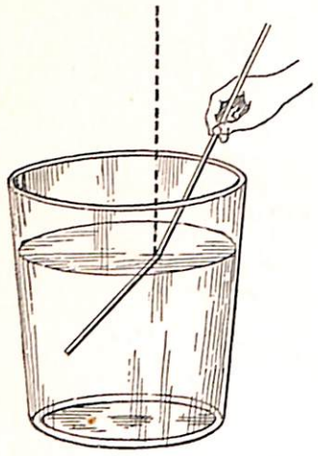
Light bounds back. That is, if it strikes an object that will not receive it or allow it to pass on, it will bound back again. This is illustrated by the looking-glass, and by various metallic substances.

The light bends. This habit of light we have not yet studied. It changes its direction to some extent when it passes from one substance into another, as from the air into glass, from air into water, from water into glass, and from glass into water. But it never changes its direction as long as it remains in a medium of the same density. If you plunge a straw into a glass of water, at an angle, you will notice that the straw *appears bent.* The straw is *not bent,* but only *appears* to be.



IN PASSING FROM ONE MEDIUM INTO ANOTHER LIGHT IS REFRACTED OR BENT

When looking into a clear pool of water, perhaps you have tried to touch some object at the bottom with a stick. Unless the object lay directly under the eye, you found difficulty in striking it, for it was not where it *appeared* to be. A straight post standing obliquely in the water will appear bent. To the boy on the bank, it seems to bend at the surface. This is because the rays of light proceeding from the part of the post that is under the water are caused to change direction, bending *away* from the perpendicular at the surface where they emerge into the air and pass to the eye of the observer. The eye is unaware of the bending of the rays at the surface of the water, and therefore the part of the post under the water *seems* to be bent away from the observer. This bending of a ray of light in passing from one medium into another is called *refraction.*



A REFRACTION OF LIGHT

Summary

1. Sunlight is white in color.
2. White light is composed of seven colors.
3. Light travels in straight lines in substances of uniform density.
4. Light is reflected, or bounds back.
5. Light is refracted. It changes from a straight line when passing from one substance into another.

Experiments

1. Admit a beam of light into a darkened room, and sprinkle a little chalk dust in the path of the light, in order that you may see the direction of its path.

2. Catch the sunbeam upon the surface of a mirror, and notice the result.

3. Drop a penny to the bottom of a tin cup, and stand in such position that the rim just hides the penny from view. Now

fill the cup with water, and explain why you can now see the penny.

4. Fill a square bottle with clear water, and lay it horizontally where the sunbeam in the darkened room will strike it at an angle and pass through it. Notice that the light changes direction both upon entering the bottle and upon leaving it.

Note Book Requirement

With the above summary as an outline, write a composition upon the "Habits of Light," copying the same into the Note Book, on pages 8 and 9.

Lesson IV

The Microscope and the Telescope

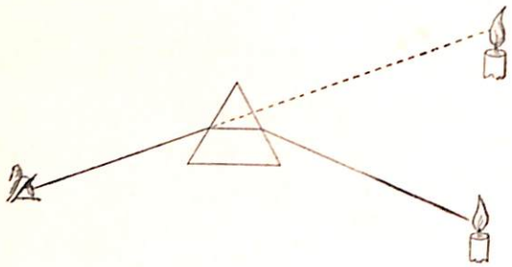
Remember that thou magnify His work, which men behold. Every man may see it; man may behold it afar off. Job 36: 24, 25.

All the habits of light contribute to our happiness and use. The study of refraction brings us to the study of two very interesting instruments that men have been able to invent because of this wonderful habit of light.

A solid that will not allow the light to enter and pass through its substance, is said to be *opaque.* Wood and stone are opaque. Anything that will but partially transmit the rays of light, is said to be *translucent.* Paper is translucent. Any substance that will freely permit the passage of light rays through it, is said to be *transparent.*

We have just learned that a ray of light, upon entering any transparent substance, as glass or water, is bent, or refracted, by the denser medium. Now the *prism* and the *lens* are both transparent solids. The prism is bounded by plane surfaces inclined to each other, while the lens is bounded by surfaces one of which must be curved.

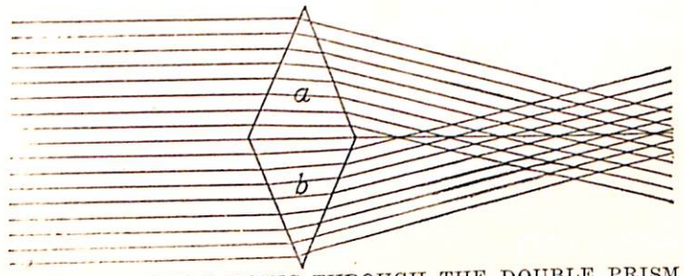
We have also learned, in our study of the refraction, or bending, of light, that the ray is bent *toward* a perpendicular to the surface where it enters; but where it emerges from the glass or water, it again bends, and thus changes direction, and in this case the direction is *away* from a perpendicular to the surface that it leaves.



THE PATH OF LIGHT THROUGH A PRISM

Let us notice the path of a ray of light through a prism. The ray of light is twice refracted. It is bent *toward* a perpendicular upon entering the prism; but upon leaving, the direction is *away* from a perpendicular to the surface from which it emerges. Draw a perpendicular to the surface where the ray enters, and another perpendicular to the surface at the point where the ray leaves the prism, and you can better see the change of direction.

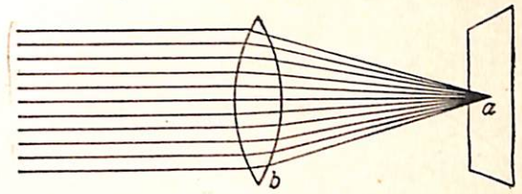
Now the eye of the observer is deceived by this refraction. We see in a straight line; and the eye, unaware of the bending of the ray, *sees* the object in the direction whence the ray came on leaving the prism, thus causing the object from which the ray was sent out to appear in an unreal position. The candle in the illustration is seen *above* the eye, while in reality its position is *below*.



RAYS OF LIGHT PASSING THROUGH THE DOUBLE PRISM

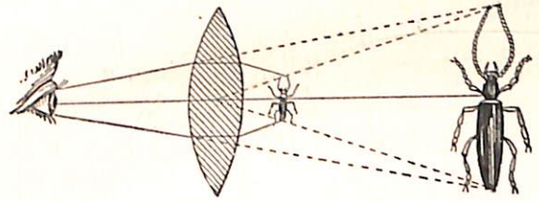
Notice this diagram. Two prisms are joined at their bases. Parallel rays of light passing through this double prism are twice refracted, and the bent rays cross one another as here shown.

The next diagram shows us that the lens is a modified double prism. The angles of the double prism are ground off, and the double curved surface of the magnifying lens is the result. Now you will see that instead of crossing each other, the rays of light are bent by the magnifying lens so that they meet at a point on the side of the lens opposite that from which they entered it.

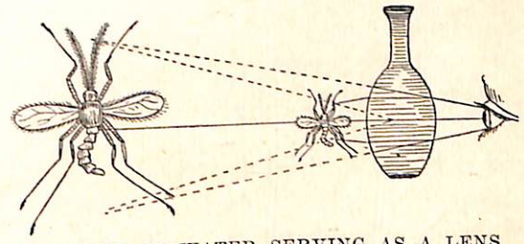


THE LENS GATHERS THE RAYS OF LIGHT AND BRINGS THEM TO A POINT

In the next diagram an insect is seen through a magnifying lens. Rays of reflected light pass from the insect through the transparent lens to the eye, being twice refracted, and brought together in the eye. The eyesight follows the rays through the lens, but is not conscious of any bend in the rays; therefore the part of the insect shown by each ray appears in the direction of the rays from the eye to the lens. Thus the parts of the insect are made to appear in an unreal position. The antennæ of the insect appear very greatly extended, and all the other parts appear correspondingly lengthened and enlarged.



HOW OBJECTS ARE MAGNIFIED

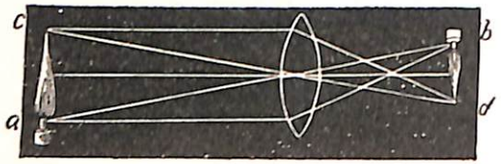


A FLASK OF WATER SERVING AS A LENS

In this diagram the flask of water becomes a magnifying lens. Rays of light from the insect beyond the flask pass through the flask and are

refracted by it. The rays are brought together in the eye. The eyesight follows the rays through the flask, but is not conscious of any bend in the rays; consequently the part of the object shown by each ray appears in the straight line that the ray takes on leaving the flask. As a result, different parts of the insect appear where they are not. Thus the parts seem extended and the entire insect enlarged.

If a luminous object, as a candle, be placed before a lens, an inverted image of the candle may be made to appear on a white piece of paper placed on the opposite side of the lens. The reason for this is that the rays of light focus, or meet, and cross each other between the lens and the paper. Be sure to have the paper beyond the focal point; if not, the image of the candle will not be inverted. Perform this experiment in a dark room. With a simple microscope which has but one lens, the focal point is in the eye and the image is not inverted. In the compound microscope or telescope, which has two lenses, the image is inverted — by which we mean "wrong side to," or "wrong side up."

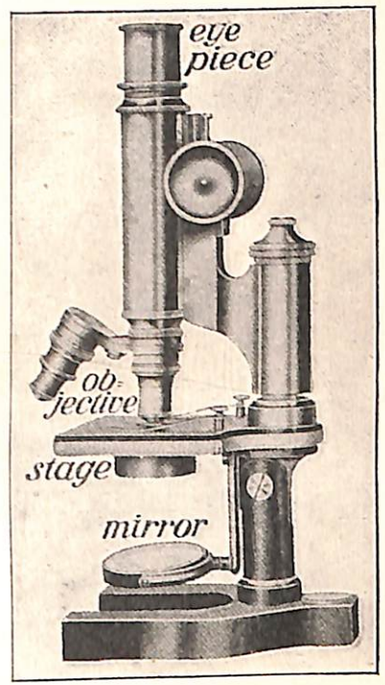


(*a c*) THE FLAME OF A CANDLE
(*b d*) THE INVERTED IMAGE PRODUCED BY THE LENS

Although the power of the lens to magnify objects was noticed long before the time of Christ, it became a useful instrument only a few hundred years ago. In 1590 the first compound microscope, it is generally believed, was made by a Dutchman named Zacharias Jansen; but for many years the microscope proved little more than a toy, because the lens colored and distorted the object as well as magnified it. Now better lenses are made, and we are able to examine easily objects that are quite invisible to the unaided eye.

Previous to 1600 the telescope was unknown. The discovery of the principle upon which the telescope works is credited to a spectacle maker of Holland. One day while holding a spectacle lens in each hand he happened to direct them toward the steeple of a certain church. What was his astonishment to find that the weathercock appeared nearer and more distinct!

The first telescopes were very crude. By means of a glass lens placed in either end of a lead pipe, Galileo discovered four of the moons of Jupiter. Galileo and others devoted much of their time to improving and perfecting the telescope. By means of patient effort they conquered the difficulties of grinding and polishing their lenses, and succeeded in producing telescopes of greatly increased power. Galileo discovered spots on the sun, and hills and valleys on the moon; and the telescope has revealed to us many other wonders of the heavenly bodies which otherwise would never have been known.



THE COMPOUND MICROSCOPE

The telescope, through which we are enabled to view large objects far off, and the microscope, which is used in studying small objects near, are wonderful and complex instruments. But we each possess a more delicately adjusted and perfectly regulated instrument than any microscope or telescope ever invented. The eye is nicely constructed by the Creator to adjust itself to the principle of refraction. Were it not for this interesting habit of light, no clear vision would be possible. There is in the eye a wonderful lens, capable of focusing the rays of light on the nerves of sight and producing distinct and correct images of the things that surround us. We shall learn more about this matter in our future lessons.

Wonderful perfection is seen in every detail of God's creation. As the lens assists in revealing this perfection in the things about us, likewise the Saviour assists in revealing the character and in magnifying the law of the Infinite One. God's perfection of character is best understood when viewed through the magnifying lens of His own choosing. Jesus is the great magnifying lens. By a life of loving ministry, He enabled man to see God's character magnified. Read Isa. 42: 21.

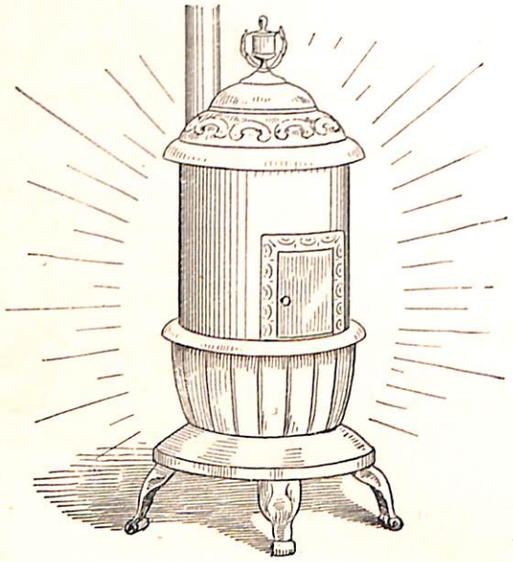
Note Book Requirement

Explain the drawings found on pages 10 and 11.

Lesson V

How Heat Travels

There is nothing hid from the heat thereof. Ps. 19: 6.



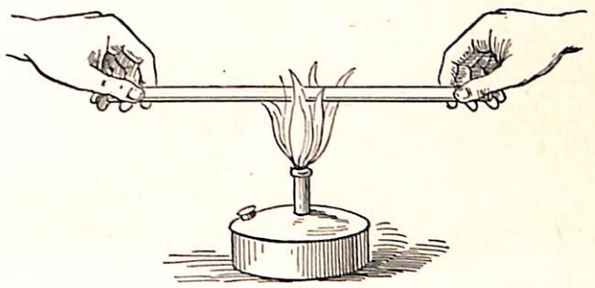
HEAT RADIATION

If any object that has a large amount of heat is near another object that possesses less heat, soon both will be equally warm. In a warmed room, all the furniture, the carpets, and even the walls become equally heated. This is because heat travels and tries to spread itself in all directions.

But although the heat from a fire spreads through all the articles in a room, and they become about equally warm, yet they do not feel so. A piece of marble does

not feel as warm as the woolen carpet. This is because marble carries off heat from the hand and leaves it cold, and the carpet does not do this. Articles that carry off heat rapidly are called good conductors of heat. Articles that do not carry off heat rapidly are called poor conductors of heat.

It is because heat travels from one thing to another, that ice melts in warm water or warm air. Some of the heat in the water or air goes into the ice and melts it, and the melting ice cools the water or air by taking part of its heat.



GLASS IS A POOR CONDUCTOR OF HEAT

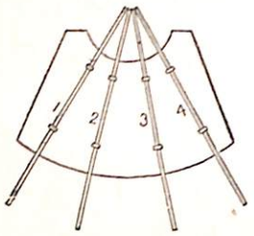
Heat travels through metals very easily. We know that iron and copper are very much better conductors of heat than wood or glass. This is why wooden handles are put on iron tools, and teakettles, and lids. Sometimes, also, we use paper to take up things that are hot, because the paper, being a poor conductor, does not let much of the heat pass through to the hand. You have seen people wrap ice in flannel to keep it from melting. Flannel is a poor conductor of heat. It prevents the heat in the air from reaching the ice.

Flannels are poor conductors because the air, which is a bad conductor, is confined among the fibers. For the same reason, furs are poor conductors. Both are worn in winter to keep the heat in the body from readily passing off. In the summer, cotton goods are worn, as they do not imprison the air, and the heat is allowed to escape more freely.

Because there is a great deal of air confined in the snowflakes that pile upon one another to form earth's winter coat, the earth and the seeds and the grasses beneath are protected.

Questions

1. How is ice melted?
2. When is anything said to be a good conductor of heat?
3. When is it said to be a poor conductor?
4. Why are the fur-bearing animals found in cold climates?
5. Why are the trees' buds wrapped in downy blankets?
6. Why is straw placed around trees to protect them from cold in winter?
7. Why are houses built with double windows, in cold climates?
8. Why do we wear woolen clothing in winter and cotton in summer?
9. Why are the bottoms of teakettles and boilers often made of copper?
10. Why are our bodies compared to stoves?



HEAT CONDUCTION

Experiment

Take wires of copper, brass, tin, and zinc, arranging them upon a flat surface as suggested by the illustration. Place wax balls on the ends of the wires; and where the opposite ends meet in a point, apply a flame. Which of these metals ranks first as a heat conductor? Which second, etc.?

Note Book Requirement

Explain, on page 12, the results of your experiment, and on page 13 explain the illustration there found, and write answers to the above questions.

Lesson VI

A Heat Measurer

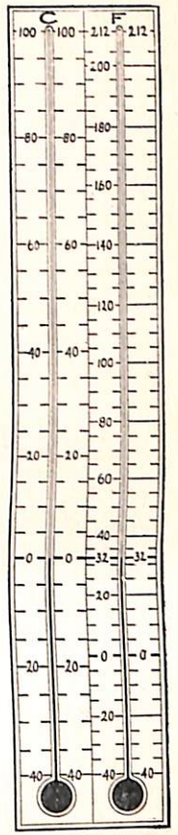
And because iniquity shall abound, the love of many shall wax cold. Matt. 24:12.

It may be noticed that our sensations of warmth and cold are only relative, and are sometimes utterly untrustworthy as

a means of measuring heat. If we place the right hand in iced water and the left in hot, and then transfer both to water of medium temperature, the left hand will pronounce the water cold, and the right will say it is warm. To measure accurately the temperature, or intensity of heat, we must have a heat measurer — the thermometer.

The word "thermometer" means *heat measurer.* It comes from two Greek words, *thermos,* warm, and *metron,* measure. The common thermometer consists of a slender tube having a bulb at one end and sealed at the other. After the air is taken out, this bulb and part of the tube are filled with some liquid, generally mercury. Either on the tube, or on the frame to which the tube is fastened, is marked a scale for measuring the rise and fall of the liquid.

When the weather grows warm, we say the thermometer rises. When it grows cold, we say it falls. We mean by this that the liquid in the tube rises and falls. Why is this? — We find that heat expands the liquid in the tube, and thus causes it to occupy more space. As the bulb at the end is full, the liquid must rise in the tube. On the contrary, when it grows colder, or in other words, when there is less heat, the liquid occupies less space — it contracts — and its level falls in the tube.



CENTIGRADE AND FAHRENHEIT THERMOMETERS

In order to know the warmth of the air, or, as we say, the temperature of the air, we look at the figures at which the surface of the liquid stands. When it is at the figure 20, we say it stands at twenty degrees above zero, and write 20°; when it is at 0, we say it stands at zero, and write 0°. Should the level of the liquid fall below 0°, we would say it is so many degrees below zero. Every one knows that below 0 is very cold. Ten degrees below zero is written — 10°.

The thermometer most commonly used was invented about two centuries ago by a German named Fahrenheit. He marked the freezing point of water 32° above 0, thinking that there was no heat below 0. The temperature of our blood he made 98°, and that of boiling water, 212°. Between the boiling and the freezing point, the length of the tube is divided into 180 equal parts, each one of which is a degree according to the Fahrenheit scale. (212° — 32° = 180°.)

Another method of marking the same temperature is used in the Centigrade thermometer. In this thermometer the temperature of melting ice is marked 0, and that of boiling water 100°. These two natural points are easily tested. A glance at the illustration will show that a degree Centigrade is greater than a degree Fahrenheit, 100° of the Centigrade scale equaling 180° Fahrenheit. Thus a degree Fahrenheit equals five ninths of a degree Centigrade. For temperatures below — 40° F., alcohol is substituted for mercury. To estimate temperatures much above 300° Centigrade, an air thermometer may be employed.

Questions

1. Define the word "thermometer," and describe one.
2. Do we need a thermometer in the schoolroom?
3. What is the temperature of the air in your schoolroom in the early forenoon? At noon?
4. Why is the Fahrenheit thermometer so called?
5. How does the Centigrade thermometer differ from the Fahrenheit?
6. What is the freezing point and what is the boiling point in each?
7. If the temperature of a room is 70° F., what is the temperature C.?
8. At what temperature C. does mercury freeze? At what temperature F.?
9. What substances besides mercury are sometimes used in thermometers?

10. Tell as many uses as you can for the thermometer, and why one is needed in each case.
11. What is the Christian's thermometer for testing his actions? Rom. 3:20; 7:7.

Lesson VII

Heat Expansion

In the study of the thermometer, we saw the expansion, or swelling, of a fluid by heat. In hot weather the mercury is high in the thermometer, because it is so much swollen by the heat. In cold weather it is low in the tube, because the cold air contracts it.

It is the same with gases. A rubber balloon half filled with air and then sealed, will be nearly filled in a very short time when hung over a stove. This is because the air is made thinner by the heat, forcing the air particles farther apart.

Heated air is lighter than cold air; and hence as air is expanded by heat, it always rises. It is pushed up by the cold air, which, being heavier, tends to settle and crowd up the warmer, lighter air. This keeps the air always moving, and produces winds. The draft in the chimney is caused by this tendency of heated air always to rise.

Heat tends to expand liquids also; and thus when water is heated, it has more volume and less density, just as does air, and therefore it is lighter. The warm water is pushed up by the heavier, cold water, and currents are established in the water, the same as in the air.

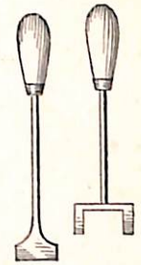
Heat expands solid substances, too, though not so much as it expands gases and liquids. If a rod of iron will just fit in a hole in another piece of iron, you can not push it into that hole when the rod is heated, because it is swollen by the heat. The tire of a wheel is made a little too small for the wheel; but

"WATCHING THE SMITHY"

Courtesy Fred C. Lounsbury

when it is expanded by the heat, it goes on nicely, because the heat has made it larger. As the tire contracts, it fits very tightly, giving firmness to the wheel.

It is the heat of springtime that wakens the seeds, and causes the buds to expand into leaves and blossoms. In the animal world, also, heat has a great work to do. Heat is a busy worker everywhere.

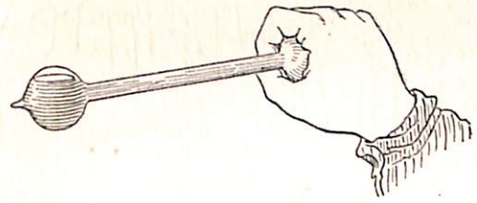


EXPANSION BY HEAT

Experiments

1. The first iron bar in this picture fits easily within the hollow of the other. If one were heated, would the two still fit together perfectly?

2. Insert a glass tube through the cork of a closed bottle containing liquid. Heat this liquid, and notice results. The heat from the hand will cause the water to rise in the tube.



EXPANSION OF AIR BY HEAT

3. The next illustration pictures a closed tube having a bulb at each end. This tube is partly filled with a liquid, and contains air. The warmth of the hand, when placed upon one of these bulbs, heats the air in the bulb, causing it to expand, and pass in bubbles through the liquid contained in the lowered bulb.

Questions

1. How does heat affect most things?
2. What causes winds?
3. Why is heated air lighter than cold air?
4. Explain land breezes and sea breezes.
5. Why does not a gallon of molasses or oil weigh as much in summer as in winter?
6. Why are the ends of steel rails that are used in building a railway track, not placed close together?
7. Why are steel bridges never fixed at both ends, but usually one of the ends rests on metal rollers?
8. Give other examples of the law of heat expansion.

Note Book Requirement

Upon pages 14 and 15 of the Note Book, explain the illustrations there found, and write answers to the above questions.

Lesson VIII

Review Questions

1. Define light. Define heat.
2. Of what is light a symbol? John 1: 4-9; 8: 12.
3. Mention sources of natural light.
4. State sources of spiritual light.
5. Mention four habits of light.
6. Describe a prism, and tell how it affects a ray of light.
7. Describe a lens, and state its use.
8. Why is our Saviour called the great magnifying lens?
9. When and by whom was the first compound microscope made?
10. Of what use is the microscope?
11. Describe the telescope, and state its use.
12. Why are some substances poor heat conductors and others good heat conductors?
13. Name the instrument that measures heat, and describe its construction.
14. Of what is heat a symbol? Rev. 3: 15, 16.
15. Of what is cold a symbol? Matt. 24: 12.
16. Which is more important, a knowledge of the things of nature, or a knowledge of the spiritual truth taught by these things?

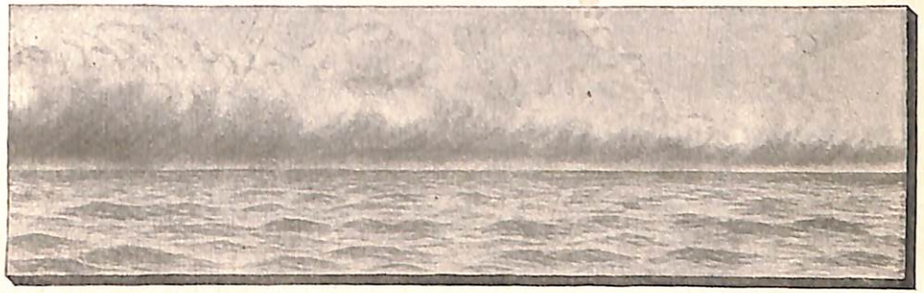
Note Book Requirement

Upon page 16 write answers to certain selected review questions.

CHAPTER III

AIR AND SOUND

(Scripture Basis, Gen. 1:6-8)



"And God said, Let there be a firmament in the midst of the waters."

Lesson IX

An Invisible Substance

He causeth the vapors to ascend from the ends of the earth. Ps. 135: 7.

The substance which God created upon the second day, to fill the firmament, is invisible, and odorless, and tasteless, and yet it occupies all space about us that is otherwise unoccupied. Although odorless and tasteless, the air wafts to us the sweet and wholesome fragrance of the great outdoors, and carries from our homes all odors that are unpleasant and harmful.

The atmosphere surrounds the entire earth to a depth of over fifty miles. When the air was created the clouds were established above, for it is the air that holds the vapor up and balances it above in clouds. Thus did God "divide the waters from the waters."

It is the air in motion that carries the clouds over the dry land, where, when they become too chilled to hold the moisture, they lose it, thus watering the parched earth. What wisdom is seen in this perfect arrangement!

Thus the all-wise Creator provided everything necessary to the plant life which He was about to create. He had in mind the needs of animal life as well, for existence would not be possible to either plants or animals without this life-giving substance.

Air is, in truth, the breath of all life. Besides serving for breathing, in both plants and animals, it is necessary also to produce heat in our stoves and light in our lamps.

Experiments

1. Fill a tumbler with water, and having placed a thick slip of paper over its mouth, press the paper down tightly with the hand, and invert the glass cautiously. The hand may now be removed, and the water will be supported in the glass by the upward pressure of the atmosphere on the paper.
2. Place a small open tube vertically in water until it is filled, then close the upper end with the finger and raise the tube. Why does not the water run out? Remove the finger, so that the atmosphere may press both from above and from below. What happens?
3. Review other experiments under lesson 11 in Book Two.

Note Book Requirement

Upon page 17 describe the atmosphere and God's purpose in its creation.

Lesson X

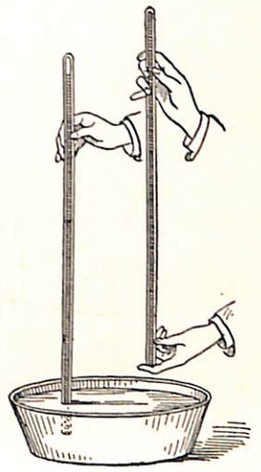
The Barometer

To make the weight for the winds; and He weigheth the waters by measure. Job 28: 25

The downward pressure of the air is the measure of its weight. The barometer is an instrument made for measuring

the weight of the air, and by it even slight changes in the atmospheric pressure can be told.

We have learned that the weight of air pressing upon the surface of water in a well or cistern raises it in the pump to the height of nearly thirty-four feet. But there are liquids much heavier than water, and the air pressure will not support so high a column of these heavy liquids in a tube.



AIR PRESSURE ON MERCURY BALANCES THE MERCURY IN THE TUBE

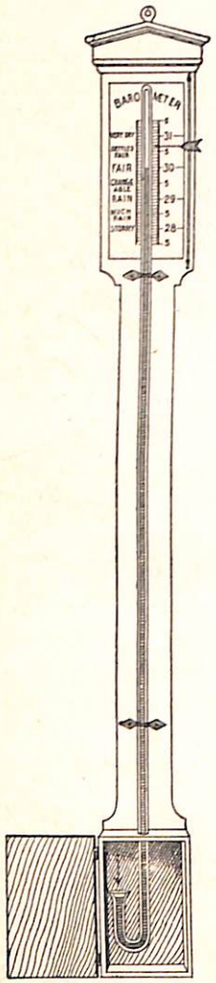
Mercury, or quicksilver, is about thirteen times heavier than water. If a tube about three feet long is filled with mercury and inverted in a bowl of the same fluid, the mercury will settle down from the top end, leaving no air (a vacuum) in the tube above the mercury. The column of mercury balanced in the tube will be about thirty inches in height.

By fastening the tube and the bowl to an upright support, and placing a scale for measuring at the side of the tube, we make an instrument for measuring the weight of the air. The tube is protected by inclosing in a case. The barometer must be in a vertical position for reading. At sea level, zero is at the surface of the mercury in the lower end of the tube.

If the barometer be carried up a mountain, the mercury falls. This is because the higher one goes, the less air there is pressing downward. The air does not weigh the same all the way up. If the barometer is carried three or four miles up a mountain, the mercury column falls about fifteen inches, or half the height of the mercury in the tube when at sea level.

Air is heavier at certain times than at others. On a bright, clear day the air is heavy, and then the mercury rises in the tube; but in cloudy, rainy weather, the mercury falls in the

tube, and rises outside in the bowl, because the air is then lighter than usual. We feel better when the air is clear and heavy. We do not feel as well when the sky is cloudy and the air is light.



THE BAROMETER
An instrument for measuring air pressure

The barometer is of great use to the sailor in telling of threatening storms; for when a storm is coming, the air is light, and the mercury in the barometer falls, of course. He looks now and then at the barometer; and if at any time he sees the mercury fall suddenly, he gets ready for a storm, which may come on very rapidly.

Note Book Requirement

Explain the illustrations found on page 18.

Lesson XI

The Composition of Air

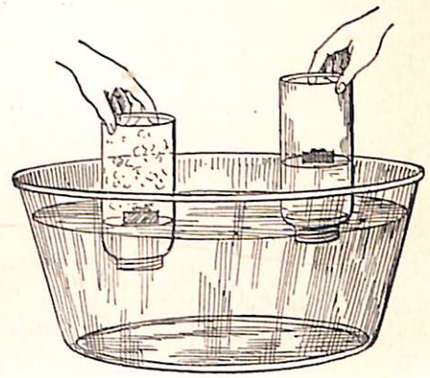
In our last lesson we learned that air is a substance, and has weight. It is a thing necessary to our life, and if it be shut out for a few minutes only, death occurs. It is as necessary to the life of plants as it is to the life of animals, being taken in by the lungs in animals, and by the leaves in plants.

Air is made up mostly of two gases mixed together. Oxygen is the most important of these two, and forms one fifth of the mixture. Nitrogen is the other gas, and it is in much larger quantity, composing four fifths of the mixture.

Oxygen is that element in the air which is necessary to animal life. Oxygen may sustain

plant life, too, though plants take from the air another gas, about which we shall learn later. It is oxygen that causes fire to burn; and lamps, candles, and other flames burn and give us light and heat because of oxygen.

The nitrogen serves principally to dilute the oxygen. It does not support life. "Ozote," another name for nitrogen, means *without life*. Neither will nitrogen sustain the lighted fire or the flame of the candle. It will extinguish a flame, while oxygen will support it.



TESTING THE COMPOSITION OF AIR

There is a gas found in the air in small quantities that all people and animals breathe out into the air. This gas is also given off by all burning things. It is called carbon dioxide, and is poisonous. This is the gas which plants can take in, and thus purify the air and make it fit for the use of man and the animals.

Carbon dioxide is heavier than pure air, and therefore may accumulate in dark cellars, in deep wells, and in cisterns.

Carbon dioxide may be recognized in various ways, as the following experiments will prove.

Experiments

1. Breathe into a fruit jar, or large-mouthed bottle, until you have filled it with carbon dioxide. Now lower a lighted candle into the jar, and notice what happens to the flame. Why does the flame go out?

2. Have two clean fruit jars. In one of the jars place a tablespoon of common soda. Pour upon the soda a tablespoon of vinegar. What takes place in the jar on adding the vinegar? Now lower a lighted candle into the jar. What is the result? What does this prove? Now pour the gas from this jar into the other, going through the same motions you would if pour-

ing out water. Do not allow any of the vinegar or soda to enter the second jar. Lower a lighted candle into this jar also. What occurs? What does this prove with reference to the weight of the carbon dioxide?

3. Procure some limewater from your druggist. Blow through a straw or glass tube into the limewater, and notice what change takes place.

Caution: This experiment to be performed by the teacher only

4. Upon the surface of water contained in any vessel, place a small block of wood, or a large cork, upon which place a little piece of phosphorus. *Be very careful in handling the phosphorus, because of its inflammability. It must be handled and cut under water.* Light the phosphorus, and quickly invert over it a glass jar. When the phosphorus fumes have been absorbed by the water, notice what occurs in the jar. Why did the water rise in the jar? What proportion of the jar is occupied by water now? What element in the air was removed by the burning phosphorus? What element remains? Test the remaining gas with a lighted splinter to learn whether the gas is oxygen or nitrogen.

Questions

1. Why do persons, before going into a cistern, lower into it a lantern or light of some kind?
2. Should the light go out, would it be perfectly safe to enter the cistern?

Note Book Requirements

1. On page 19 of Note Book explain the fourth experiment.
2. On page 20 answer the above questions.

Lesson XII

The Trade Winds

He bringeth the wind out of His treasuries. Ps. 135: 7.

The air is constantly moving about, rising, falling, sweeping this way or that way, and blowing from place to place. As

the Bible tells us, "The wind bloweth where it listeth [pleases]." John 3: 8.

Because of the direct rays of the sun falling upon the Torrid Belt, the air at the Equator becomes more heated than the air elsewhere; and as the air in the Torrid Belt becomes heated, it rises, and cool air rushes in to take its place.

If there were no other influences at work, the wind at the Equator near the earth would always blow from the poles; but there is something else to be considered. We have learned that the earth rotates daily upon its axis, turning from west to east.

Now the circumference of the earth at the Equator is about 25,000 miles. It takes the earth twenty-four hours to turn once around on its axis, but the earth does not move as fast at the poles as it does at the Equator. The great sea of air which surrounds the world moves around with the earth. But a current of air from the North Pole moving southward does not at once catch the rapid motion of the earth at the Equator. Hence the wind from the poles falls behind the motion of the earth, and although it is going in the same direction, seems to blow from the opposite direction. If you were riding very fast in the cars, and should glance from the window at an object moving slowly in the same direction, it would seem to be flying the opposite way.

The earth moves from the west to the east; but these cold winds from the poles, falling behind the motion of the earth, take a westerly direction. Now a wind is always named from the direction from which it blows, and accordingly these winds are called northeast winds in the Northern Hemisphere, and southeast winds in the Southern Hemisphere.

The name given these constant winds from the poles is "trade winds." They are thus named because they waft vessels along on their journey and thus help men to trade with different countries. They extend some distance north and south of the Equator. The elevation of our high mountain ranges breaks them up, and they do not girdle the earth.

Questions

1. What influences are at work to produce winds near the Equator?
2. Describe the rotation of the earth upon its axis.
3. Locate places upon the earth's surface that lie in the belt of most rapid motion.
4. How does the rotation of the earth upon its axis affect the direction of winds blowing toward the poles? Illustrate with globe.
5. How are winds usually named?
6. Name the winds that blow from the poles.
7. What is their common name? Give the reason for this name.
8. In what belt of the earth's surface do these winds prevail?

Note Book Requirement

Upon page 19 illustrate the trade winds by diagram.

Lesson XIII

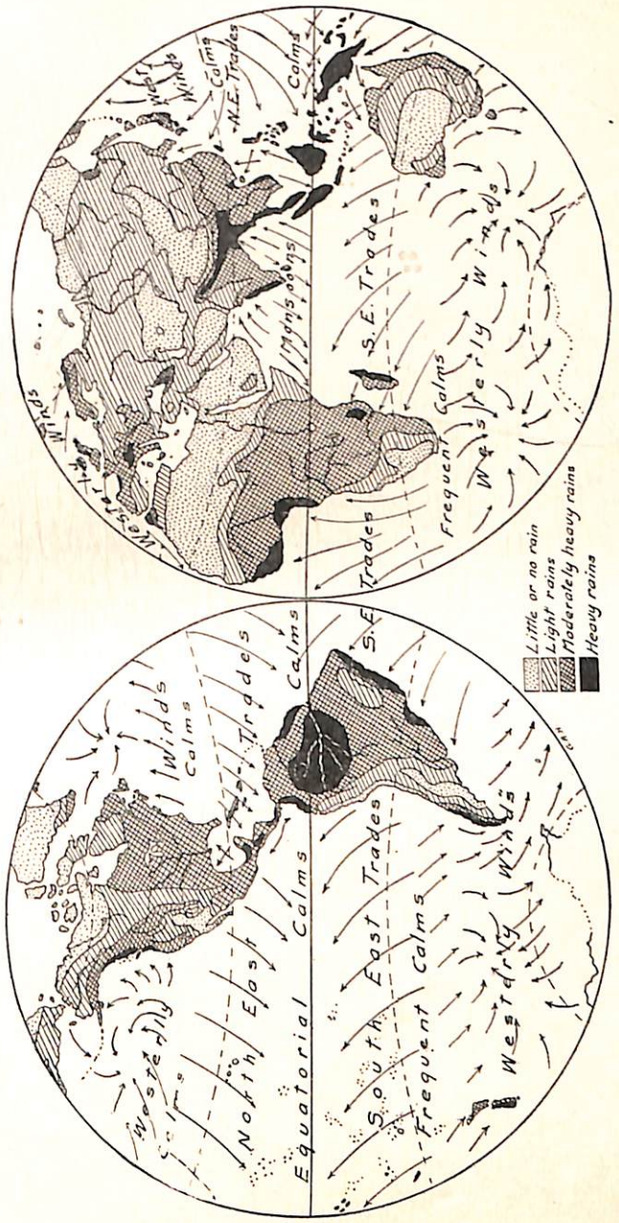
Wind Circuits

The wind goeth toward the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits. Eccl. 1: 6.

Solomon, the wise man, understood the wind and its circuits; and because he lived in Palestine, a country north of the Equator, he tells us about the winds that blow in the Northern Hemisphere.

This wind that "goeth toward the south," in the *Northern Hemisphere,* is one of the winds of which we studied in our last lesson,— the wind which takes a southwesterly direction in the equatorial region, and is known as the "trade wind."

Now why does this wind "turn about unto the north"? You remember that in the equatorial region the air is heated, and because heated air expands, it is pushed up. The cold air



THE TRADE WINDS PREVAIL IN THE EQUATORIAL REGIONS. THE ANTI-TRADES, OR WESTERLY WINDS, PREVAIL IN THE TEMPERATE ZONES.

which pushes the heated air up, becomes heated, and, in turn, is pushed up by more cold air rushing in to take the place of the heated air. This is continuously taking place; and part of the warm air which is pushed out of the way, moves northward into the Northern Hemisphere, and the other part moves southward into the Southern Hemisphere.

Finally it becomes chilled and settles down, mingling with the cold air that is traveling toward the Equator. Thus "it whirleth about continually, and the wind returneth again according to his circuits."

The winds which blow from the equatorial region toward the north and toward the south, start with the rapid motion of the earth at the Equator. As these winds approach the poles, they reach air in less rapid motion, and hence blow in an easterly direction. In the Northern Hemisphere they take a northeasterly course.

These winds are called *anti-trade winds*. "Anti" means *against*. You remember that the trade winds take a westerly direction; and since these returning winds take an easterly direction, they are well named *anti-trade winds*. The anti-trades become surface winds in the Temperate Zones.

Questions

1. What did the wise man say about the winds?
2. Where in the Bible do you find this?
3. Locate Palestine on the map.
4. In the Northern Hemisphere which way do the trade winds blow?
5. In the Southern Hemisphere which way do they blow?
6. Why do these winds take a southerly direction in the Northern Hemisphere, and a northerly direction in the Southern Hemisphere?
7. Why do they not blow directly south and directly north?
8. Why do the trade winds blow in a westerly direction?
9. Why do the anti-trades take an easterly direction?
10. In what region do the trade winds prevail?
11. In what zones do the anti-trades prevail?
12. Of what use are these winds?

Note Book Requiremnt

Upon your diagram indicate the anti-trades. (Page 19, Note Book.)

Lesson XIV

Transmission of Sound

We have already learned that air is the medium through which sound travels to the ear, and that without air this earth would be a world of silence. The air makes it possible for us to hear the sweet music of the birds, the rippling of the brooks, and the patter of the rain. By sounds we communicate with one another; otherwise we would find it necessary to talk by signs, as do the deaf and dumb.

We have watched the vibrations of the tuning fork, and have learned that the rapidly moving prongs set in motion tiny air particles, which in turn jostle against other air particles and produce waves of sound. These sound waves travel from the fork in every direction; and just as far as their motion reaches, the tone is carried.

By shaking one end of a rope that stretches along a floor, waves of motion are made to travel from one end of the rope to the other. We have often noticed how the waves on a pond of water spread outward in all directions from the center of disturbance. The waves of motion in the rope travel only in a straight line, and the waves of motion upon the water travel on a horizontal plane only, while the waves of sound are carried through the particles of air in every direction from the center of sound vibration. This is the reason we can usually hear a sound in all directions from it.

Sound does not travel as rapidly as light. You see the flash of a distant gun, or the puff of steam from a whistle, and later you hear the sound. A man at a distance, chopping wood, lifts his ax high, and is ready for a second blow, before you hear the

sound of the first stroke. The rolling thunder reaches our ears long after we see the flash of lightning that caused it. It is estimated that sound can travel through the air at the rate of a little more than one thousand feet a second.

Careful experiments prove that sound travels through different mediums at different rates. It will travel through oxygen at nearly the same rate as through air; through hydrogen gas at the rate of more than four thousand feet a second. Sound is also transmitted by water and other liquids. When bathing, have you ever struck two stones together under water and tried to hear if they made any sound? Or if, while your head was under water, some one struck the water a blow, did you not hear the sound? Sound is said to travel through water at the rate of nearly five thousand feet a second.

We have learned that gases are sound conductors; *liquids* are sound conductors; are *solids* also capable of transmitting sound? We shall see. Go stand near a long piece of timber. If one scratches the end of the timber with a pin, the sound can be heard very distinctly by one who places his ear close to the opposite end of the timber; but if he stands a few feet away from the timber, no sound can be heard. Did you ever put your ear to the rail to hear a distant train? Thus we see that solids also are good sound conductors.

It has been proved by careful experiments that sound is transmitted through iron at the rate of sixteen thousand feet a second. Solids are, on the average, about four times better than liquids as sound conductors; liquids are four times better than gases, making solids about sixteen times better than air, and water four times better.

Sound, as well as light and heat, may be reflected. We call the reflection of sound an *echo*. The waves or pulses of the air are thrown against a wall or other opposing surface, and the sound is reflected. Even the surface of a cloud serves to reflect sound, as may be observed during a thunderstorm. It is no uncommon thing for the edge of the forest to return an echo.

Experiments

1. Place a row of marbles in the pen trough of your desk. Strike the first against the second. Explain how the last marble is affected.

2. Strike a tuning fork, and touch it to the still surface of a glass of water. How do you account for the fine spray and ripples? Touch a vibrating tuning fork to the teeth, and also place it on the end of the tongue. Explain the sensations produced.

3. Make a string telephone. First open two tin cans. Next pierce a hole through the bottom of each, and pass a long string through these holes, tying a knot on the inside of each can to prevent the string from slipping out again. Now stretch the string its full length. Hold one can to your mouth, and have some one else hold the other can to his ear. Try whispering back and forth. The string should be held taut.

Questions

1. Explain how sound travels.
2. In transmitting the wave motion to a rope, do the particles of rope move far?
3. In transmitting wave motion to water, do the particles of water move far?
4. What, then, do you conclude concerning the motion of the particles of air through which sound is transmitted?
5. What is the difference between transmitting motion waves and moving a body?
6. Give other illustrations of the transmission of force and motion.
7. If sound waves traveled only in one direction, as do the waves of the rope, what would be the result?
8. If they traveled in a horizontal plane, as the waves of water seem to do, where would the ear have to be to hear the sound?
9. Why can we hear sound in all directions?
10. Explain the use of tubes and megaphones.
11. Explain why the explosion of a powder magazine broke nearly all the windows in a city near.
12. Prove that sound travels through water; through solids.
13. If six seconds intervene between seeing a lightning flash and hearing the thunder that caused it, how far away was the lightning?

14. Can you cite any instances where a knowledge of the velocity of sound might be useful to any one?

Note Book Requirement

Upon page 21 of Note Book, copy answers to questions.

Lesson XV

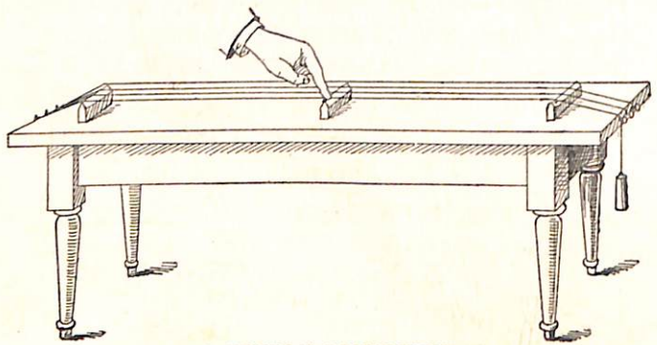
Stringed Instruments

Praise Him with stringed instruments and organs. Ps. 150: 4.

In previous books we have become familiar with wind and reed instruments. One other kind — stringed instruments — is left for us to consider. These are so called because the musical tones are produced on strings or cords. Let us try a few experiments, in order that we shall become thoroughly acquainted with the principles on which stringed instruments are constructed.

Experiments

1. Fasten a strong cord to a door knob; pull the cord with one hand, and pick it with the other. What is the result? Take hold of the cord one foot from the place where it is fastened; pick it with the other hand. Keep the tone in mind, and repeat the experiment with a two-foot, a three-foot, and a four-foot length, and compare the tones as to pitch. Does the pitch change with the tightness as well as the length of the string?



A SIMPLE SONOMETER

Provide several wires with different diameters. Fasten them to an old table by means of nails

driven two inches apart into the ends of the table. Make of wood two triangular bridges twelve inches in length. Place one of these at each end of the table, under the wires, to hold the wires up from the table and stretch them. Make several short bridges to be used in lengthening and shortening the wires, so adjusting them as to be able to produce the scale of eight tones.

These two experiments, if rightly performed, will demonstrate that musical tone can be produced by the vibration of the strings or wires, and that the pitch depends on —

1. The length of the string. The longer the string, the lower the pitch; the shorter the string, the higher the pitch.
2. The tension (tightness) of the string. The greater the tension, the higher the pitch; the less the tension, the lower the pitch.
3. The diameter of the string. The greater the diameter, the lower the pitch; the less the diameter, the higher the pitch.

You should experiment with various stringed instruments, as the violin, the guitar, and the mandolin, until these principles are clear to you. The piano is a stringed instrument. Examine its wires, noticing the variation in length and diameter.

These same principles apply to the wind and reed instruments, you will remember. If you have not had the privilege of studying these, you should satisfy yourself by examining the flute, the fife, or piccolo, and the French harp (mouth organ), the accordion, and the organ.

There is another instrument which we have not yet studied, and it is the most wonderful of all. It is the instrument that produces the human voice. It can talk! It can sing! It is capable of producing the grandest harmony and the sweetest melody of any instrument ever made.

This instrument is located in the windpipe at the point called "Adam's apple," but properly called the *larynx*. It has cords, but not like those of the violin. Instead of being slender strings, they consist of thin extensions of membrane from the sides of the walls of the music box. These two membranes, loosened and tightened by muscles, meet at the center of the windpipe, and vibrate like a reed as the air passes between them.

To what class does this musical instrument belong? Since it requires air to operate it, and since the membranes vibrate like a reed as the breath passes between them, and since, also, the membranes, or *vocal cords*, as they are called, are loosened and tightened, as is the case with stringed instruments, we shall not be able to class it with either the wind, the reed, or the stringed instrument, but must consider it as a combination of all three. It is the union of three instruments in one that makes it surpass them all.

Let us appreciate this instrument, and learn how to use it in speech and in song to the glory of God. The voice should be trained to speak and sing melodiously. The hands should be trained to play skillfully.

Questions

1. Describe wind and reed instruments. Give three examples of each.
2. Describe a stringed instrument, and name five instruments of that class.
3. Describe the instrument that produces voice. To which class does it belong?
4. How does the human voice compare with other instruments?
5. Should we learn to play on instruments of music? Ps. 33:1-3; 150:3-6. For what purpose?
6. What ought we to do with the voice instrument?
7. What place did the Israelites give to vocal and instrumental music? 1 Chron. 15:16; 16:42; 2 Chron. 5:12; 20:21, 22.
8. Will there be music in heaven? Rev. 14:1-3; 15:1-3.

Note Book Requirement

Write a composition on pages 22 and 23, on "Musical Instruments," using the following outline: —

1. Kinds: (a) Wind; (b) Reed; (c) Stringed.
2. How operated.
3. How pitch is regulated.
4. Common instruments of each kind.
5. Purpose of musical instruments.
6. Music in heaven.

CHAPTER IV

WATER

(Scripture Basis, Gen. 1:9, 10)

"And God said, Let the waters . . . be gathered together unto one place."

Lesson XVI

The Ocean and Its Arms

When He gave to the sea His decree, that the waters should not pass His commandment: when He appointed the foundations of the earth. Prov. 8:29.

Questions

1. When God caused the gathering of the waters upon the third day to take place, by what name did He call the waters?
2. At the present time, how much of the earth's surface consists of water?
3. What are we told, in Prov. 8:27, God set upon the face of the deep?
4. What are the great bodies of water now called?
5. How many are there? and what is the order of their size?
6. What is a lake?

7. Name and define other bodies of water that we have in the dry land.
8. Where does the water in the springs, brooks, and rivers come from? Where is it going? Eccl. 1:7.
9. What is God's purpose in taking water out of the ocean and raining it upon the dry land? Ps. 104:11-13.
10. What is a sea? A gulf? A bay? A strait? An archipelago? (See Book One.)
11. Name a bay and a sea that are arms of the Arctic Ocean.
12. Name and locate a gulf, a bay, and a sea that are arms of the Atlantic Ocean.
13. Name a bay and two seas that belong to the Indian Ocean.
14. Name one gulf on the coast of North America, and four seas on the coast of Asia, that are arms of the Pacific.
15. Locate upon the map Bering Strait, Davis Strait, Strait of Bab-el-Mandeb, and Strait of Gibraltar, stating what large bodies of water are connected by each.

Note Book Requirements

1. Locate upon the hemisphere maps the five oceans, and indicate by a diagram the relative size of each. (See page 55 of Book Two, or page 60 of True Education Reader Series, Book Three.)
2. List all large ocean arms, and all straits, mentioned in the questions, and locate them on the map in the Note Book.

Lesson XVII

Ocean Currents

Thou coveredst it [the earth] with the deep as with a garment. Ps. 104:6.

The waters of the mighty oceans fill the great hollows of the earth's surface, covering a considerable part of it, dividing continent from continent, and yet furnishing a highway for communication and trade between all lands; receiving from lake and river constantly, but in turn constantly giving back to the earth of their abundant supply.

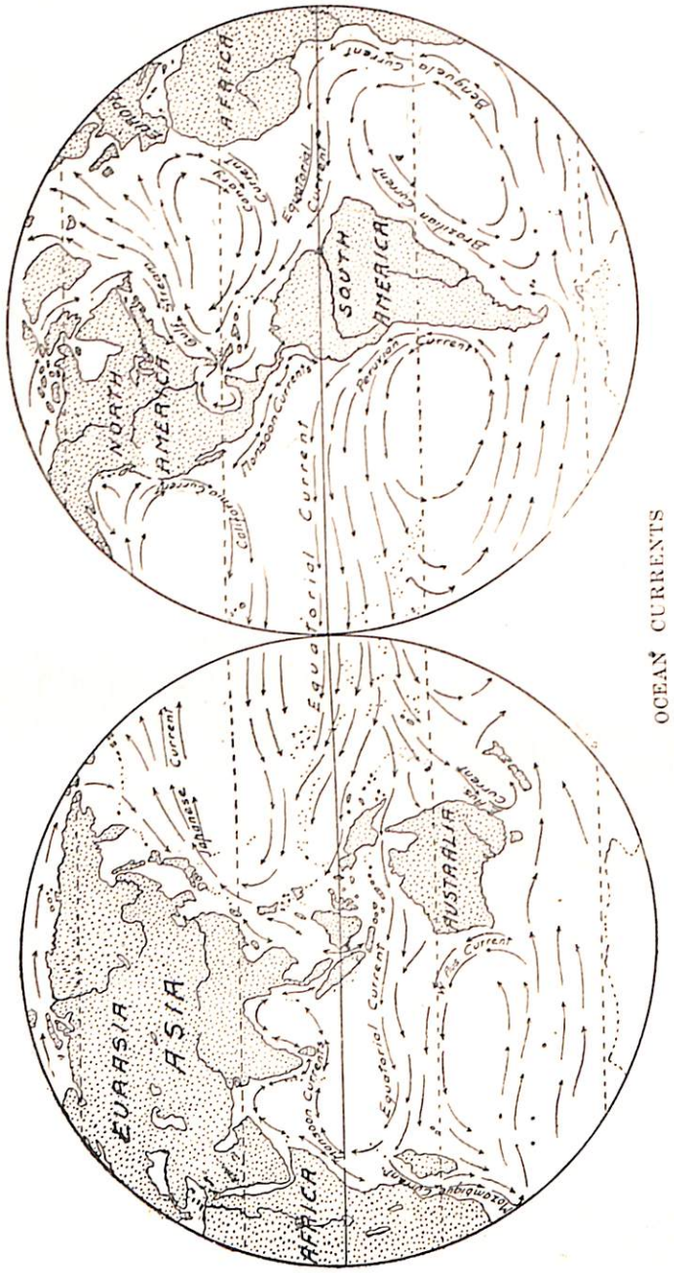
Although in the beginning not so large a portion of the earth's surface was hidden by water, yet, even in God's modified plan, we can see that He has written upon the waters the law of service, and thus the waters of the great deep are made to minister to the life of His creatures.

Like the air, the ocean water is in constant motion; and these movements, like those of the wind, are of great service to man. In fact it is the movement of certain steady winds upon the surface of the water, that, in connection with the rotation of the earth upon its axis, brings about certain well-defined ocean movements known as *ocean currents*.

We have just been studying the prevailing wind circuits known as *trades* and *anti-trades*. A comparison of these wind circuits and the ocean currents represented upon the map, shows that there is a close resemblance between the direction of ocean currents and the direction of the regular winds.

We remember that in the Northern Hemisphere the prevailing trade winds take a southwesterly direction, while in the Southern Hemisphere the prevailing direction is toward the northwest. We now observe that the direction of the north equatorial ocean current is southwest, and that the south equatorial drift, or current, moves in the general direction of the trade winds of the Southern Hemisphere. These trade winds, blowing steadily across the ocean, seem to push the water in the direction in which they move.

In the Atlantic Ocean the equatorial drift moves toward the South American coast. Before reaching the coast, it divides, the smaller portion going southward into the south Atlantic, and the larger portion going northwest into the north Atlantic. A portion of the north equatorial drift enters the Caribbean Sea, and a part of it passes farther on into the Gulf of Mexico. It escapes through the Florida Strait, and sweeps into the great Atlantic Ocean. It is now called the *Gulf Stream*. Being turned to the right by the earth's rotation, as are the anti-trade winds, and being pushed along by the prevailing winds, the Gulf



OCEAN CURRENTS

Stream flows northeast toward northern Europe, carrying with it warmth and moisture, thus greatly modifying the climate of the British Isles and the Scandinavian peninsula.

The *Japan Current* is a similar stream in the Pacific Ocean. Starting northward from the equatorial current of the Pacific Ocean, it flows toward the western coast of North America, and carries to western North America an influence similar to that of the Gulf Stream upon northwestern Europe.

The south equatorial drift in the Atlantic Ocean modifies the temperature of eastern South America, and in the Pacific Ocean, the climate of New Zealand and southeastern Australia.

Aside from affecting climate, ocean currents influence the movements of vessels at sea, aiding or retarding according to their direction. They are further important in causing fogs, which modify the climate of the adjacent land. Oxygen and food are borne by these currents to sea animals living in the cold regions of the north, and cold currents from the Arctic and Antarctic oceans flow toward the Equator to replace the outflow of warm water. These carry a chilly temperature to the lands which they bathe. Important among the cold currents is the Labrador Current, which closely hugs the northeastern American coast, bringing drifting sea ice and icebergs from the Arctic Ocean. These drifting icebergs move southward many miles, and are much dreaded by sailors, but they finally melt and disappear in the warm waters of the Atlantic. Even the cold current itself sinks or disappears by mingling with water of a higher temperature. This coming together of the cold and the warm currents of water in the northern Atlantic is the occasion for many very dense fogs. Sailors have learned to expect heavy fogs especially as they pass near the coast of Nova Scotia and Newfoundland, which is one of the regions most affected by fogs of any in the world.

Questions

1. What law is written upon all things in nature?
2. By whom is this written? For what purpose?

3. In the beginning did the water cover so large a part of the earth's surface?
4. How will it be in the new earth?
5. Why should the ocean currents give us a new reason for thinking of the Creator's goodness?
6. Locate upon globe and map all the currents mentioned in this lesson.

Lesson XVIII

Inland Water Distribution

Who giveth rain upon the earth, and sendeth waters upon the fields. Job 5:10.

A bird's-eye view of the continents reveals at a glance large bodies of water scattered here and there, and extending often over a considerable portion of the land's area. Some of these bodies of water are fresh, although extensive, while others are salter than even the waters of the ocean. Some of these inland waters nestle high in mountainous regions; others occupy depressions lower than the level of the sea.

Fed always by flowing streams, by the tiny rills and the broad rivers, the inland body of water will remain fresh and pure just so long as it passes on the precious inflowing treasure to valley and plain below.

Furnishing inland reservoirs for moisture, supplying water to cities, providing water power for manufacturing enterprises, furnishing important waterways to commerce, these sparkling sheets of silvery water are both useful and scenic.

Upon the banks of the navigable rivers and upon the shores of navigable lakes large cities and towns are built. Some of these cities are commercial centers and the scene of much trade; others are built for resort, for in summer the heat of inland regions is often much modified by the cool breezes from lake and river, and hither the people flock for rest and pleasure.

The large rivers and lakes of a continent not only supply

HARRIS FALLS, NEW ZEALAND

needed moisture, but serve also as a drain to the dry land, carrying away all the water that is not wanted, and thus bringing together in one main stream the moisture that falls in places hundreds of miles apart.

When the water is not thus collected, great disaster results. Towns and farms are then flooded, and often much property and even life is lost. In many places men build banks of earth, called *levees,* to keep the water of a river from overflowing its usual channel; and these levees must frequently be repaired, or floods can not be avoided.

In South America the lakes are few in number. Maracaibo, the largest, is a coast lagoon. Lake Titicaca is situated more than two miles above the sea level in the Andes Mountains. It is the highest navigable lake in the world.

Europe has more lakes than any other country excepting North America. The Alpine lakes are famed for their beauty, and those in the northern part of the continent for the remarkable clearness of their waters.

Asia is noted for the great number of its salt lakes. The Caspian Sea is really a lake. It is the remains of a much larger body of water which was once connected with the Aral Sea. It has no outlet, and its waters are salt, though not so much so as the water of the ocean. The Aral Sea is another salt lake of considerable size. Still another salt lake of that continent is known as the Dead Sea. Lake Baikal is the only very large fresh water lake in Asia.

The great lakes of Africa are in the southern highlands. They rival in size those of North America. Victoria Nyanza is the largest of these. Lake Tanganyika and Lake Nyassa are south of Lake Victoria. Lake Chad is in the central inland region, north of the Equator.

Australia contains numerous lakes which have no outlet to the sea, and hence are salt.

Inland bodies of water supply many valuable fish, and in winter much ice is cut from the frozen surface of rivers and lakes.

Just as the water is freely sent us by our heavenly Father, so He abundantly showers upon us the blessings of His grace, and refreshes us by His words of life and truth. Let us thank Him for both temporal and spiritual blessings, and pass them on to others, even as does the stream its currents of life-giving fullness.

Questions

1. Describe a stream or other inland body of water which you have seen.
2. Describe a small stream in the mountains.
3. Where do rivers obtain their waters?
4. What is meant by the source of a river? What by its mouth?
5. What is sediment?

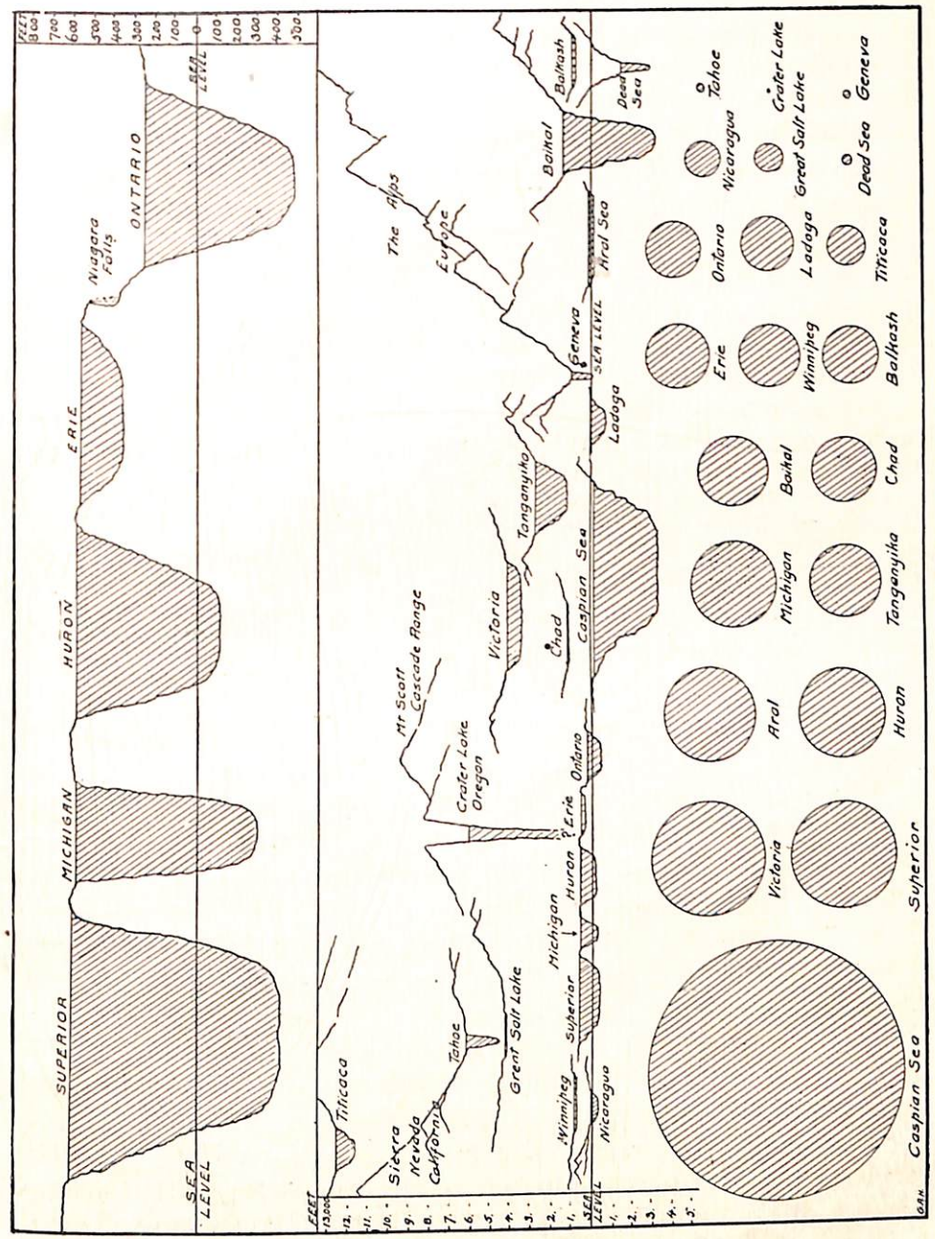


DIAGRAM OF DEPTH, ALTITUDE, AND SIZE OF LAKES

6. Explain how a delta is made.
7. What are levees?
8. How are rivers useful for drainage?
9. Give reasons why cities have sprung up near rivers.

Note Book Requirements

On Mercator's projection —

1. List and locate by number the principal lakes of each continent, also principal rivers.
2. Name oceans and important ocean arms, coloring the same with blue crayon.
3. Describe the important rivers thus located.

Model: The Mississippi River rises in the central part of North America, flows south through the great central plain of the continent, emptying into the Gulf of Mexico, an arm of the Atlantic Ocean. It has many great tributaries. The Missouri-Mississippi River is the longest in the world.

Lesson XIX

Blessings of Water

For He maketh small the drops of water: they pour down rain according to the vapor thereof: which the clouds do drop and distill upon man abundantly. Job 36: 27, 28.

Light, heat, and air are all indispensable to life. So also is water. Let us enumerate its uses:—

As a *gas* water propels machinery, as illustrated by the steam engine. It is used for heating purposes, the heat being distributed by means of steam pipes.

As a *solid* water is a protection to plant and animal life in cold weather. This is because in that form it is a poor heat conductor, and thus the little creatures of the field, and the tiny roots and seeds, are not frozen by exposure, but keep snug and warm under their white blanket of frozen water. The melting snow in the mountains keeps the streams full of water in the

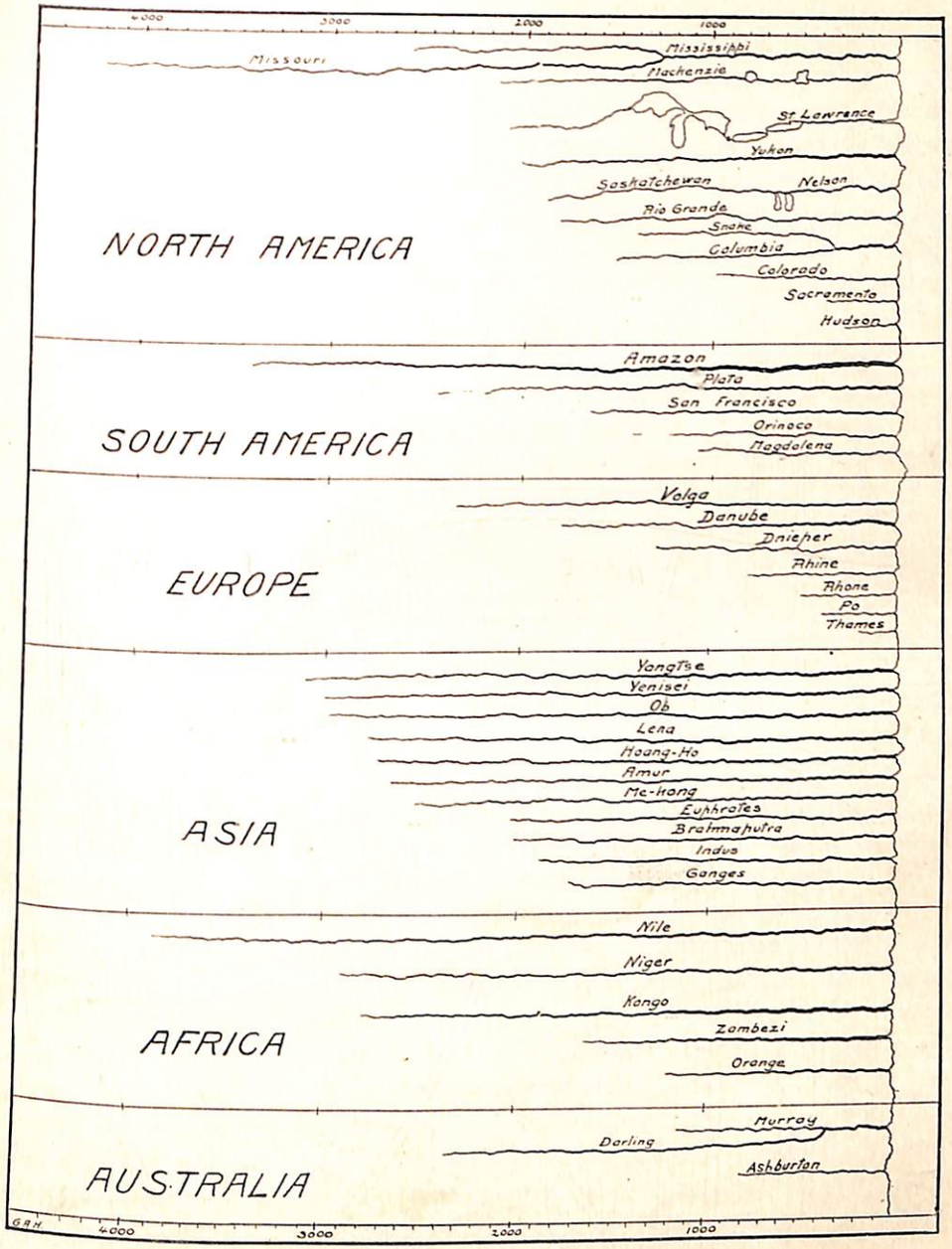


DIAGRAM OF COMPARATIVE LENGTHS OF GREAT RIVERS OF THE WORLD

dry season, and provides water for irrigation during the long, dry summer months. Frozen water is also a blessing in our homes in hot weather, preserving perishable materials, and making food and drink more palatable. It is of use in sickness, also, reducing fever and inflammation when properly applied.

As a *liquid* water is indispensable in many, many very ordinary ways. And how abundantly does this sparkling liquid minister to our comfort and pleasure! Indeed, could we exist without it? Is there any other liquid so valuable?

As dew and rain it falls upon the earth, cooling the atmosphere, and refreshing the land. You do not need to be told that it is absolutely necessary to plant and animal growth. From our study of foods, we know that they all contain water, and that a part of the body's need of this fluid is supplied by them.

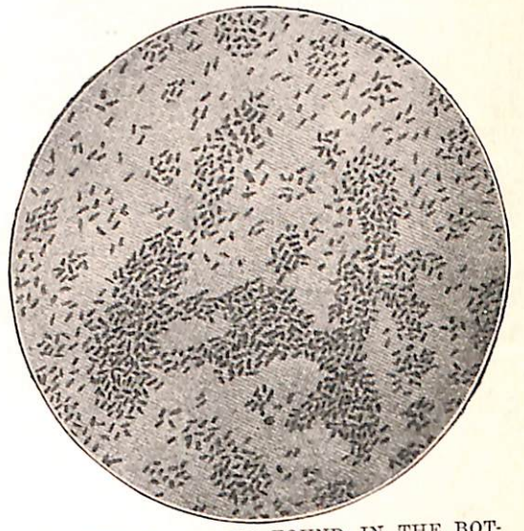
Chemists estimate that nearly three fourths of the human body is water. Blood is nearly four fifths water, and every tissue of the body has its share. In fact, if all the water were pressed out of the tissues of a healthy person weighing one hundred twenty pounds, the substances remaining would not amount all together to more than forty pounds. Thirst is the craving of the body for water, and there is absolutely no other beverage so satisfying.

Aside from being one of our best building materials, water is also a cleansing agency. It eliminates poisons from the body. We know that it will loosen dirt from soiled clothing, and that it is useful in cleaning dishes, floors, and anything else that needs cleansing. This is because of its *dissolving* quality; and just as it is able to loosen dirt from the clothing, and carry waste through sewer pipes, so it can, in the blood, take up injurious and useless substances, and carry them from the body through the kidneys, the lungs, and the skin.

Our bodies can not perform their best service unless all parts are thoroughly clean, and the free drinking of water is one of the greatest helps in accomplishing our inner house cleaning. However, we ought to know that drinking too freely of water

at meals may be an injurious practice, because it is likely to lessen the supply of digestive fluids, and if taken in too large quantities, may overdilute them. But a glass or two of water just before retiring at night, or two or three glasses of water a half hour or more before meals, especially before breakfast, are most effective in keeping the inside of our bodies clean and healthy.

Great pains must be taken to have our drinking water pure. Water very readily takes up gases and bacteria that may be in the air, and it also dissolves minerals and poisons with which it comes in contact, carrying them in solution. When we consider that thousands of deaths from germ diseases occur yearly, the necessity of being careful about our drinking water can be easily appreciated.



DIPHTHERIA GERMS FOUND IN THE BOTTOM OF A DRINKING CUP

The boiling of drinking water will kill all germs if it is boiled about twenty minutes after the steam begins to rise. Another benefit from the boiling of water is that some of the mineral substances in solution are deposited, and both the purity of the water and its dissolving power are thus increased. Filters are also often used to purify drinking water.

But there is no other process of purifying water that may be considered so thoroughly safe as distillation. Distilled water is condensed from steam, and is very pure; for whatever mineral or other substances it might have held in solution before the steam was formed, are left behind. Because water very readily takes

up gases and bacteria, it should not be left long uncovered when it is to be used for drinking. Care in this respect is especially necessary in the sick room.

The freezing of water does not always kill the germs of disease, and therefore care must be taken in the use of ice that has been cut from sewage-laden streams. Drinking water may be cooled by placing the vessel of water on ice. This is a safer way than putting the ice into the water.

Many other blessings of water might be mentioned. How could the housekeeper cook and get along without water? How could the physician and nurse dispense with this cleansing, dissolving, diluting agent? Simple water remedies are more effective than costly medicines, and far better, because they do not unduly tax the body.

A bottle of hot water placed next to the body suffering from pain or congestion, often brings quick relief. Cold water quickly takes the numbness out of frozen hands or feet. Do not forget that the bath, properly taken, purifies, rests, and strengthens the entire body. Is not water one of God's greatest gifts?

Questions

1. Enumerate the uses of water as a gas.
2. State its uses as a liquid.
3. Of what use is it as a solid?
4. What are its uses in ill health?

Note Book Requirement

On page 27 of Note Book write in your own words a composition upon the lesson topic.

Lesson XX

Review Questions on Water

1. Of what is water a symbol? Rev. 22: 17.
2. Name the three conditions of water.

3. Mention forms of *solid*, *liquid*, and *vaporized* water.
4. State work done by water in each form.
5. Name and describe three kinds of water wheels.
6. Define *ocean*, *gulf*, *bay*, and *sea*.
7. Define *spring*, *lake*, *river*, *river basin*, *river system*, and *watershed*. Give an example of each.
8. Explain Eccl. 1: 7.
9. Name the oceans in order of size.
10. What proportion of the earth's surface is covered with water?
11. What proportion of the human body is water?
12. How much of the blood in the body is water?
13. Is there any one who can estimate the amount of water on this earth? Job 28: 25.
14. Name and describe four forms of clouds.
15. Of what two gases is water composed? and in what proportion do they unite to form water?

BOSPORUS, WITH CASTLE OF EUROPE

CHAPTER V

DRY LAND

(Scripture Basis, Gen. 1:9, 10)

"And God said, . . . Let the dry land appear."

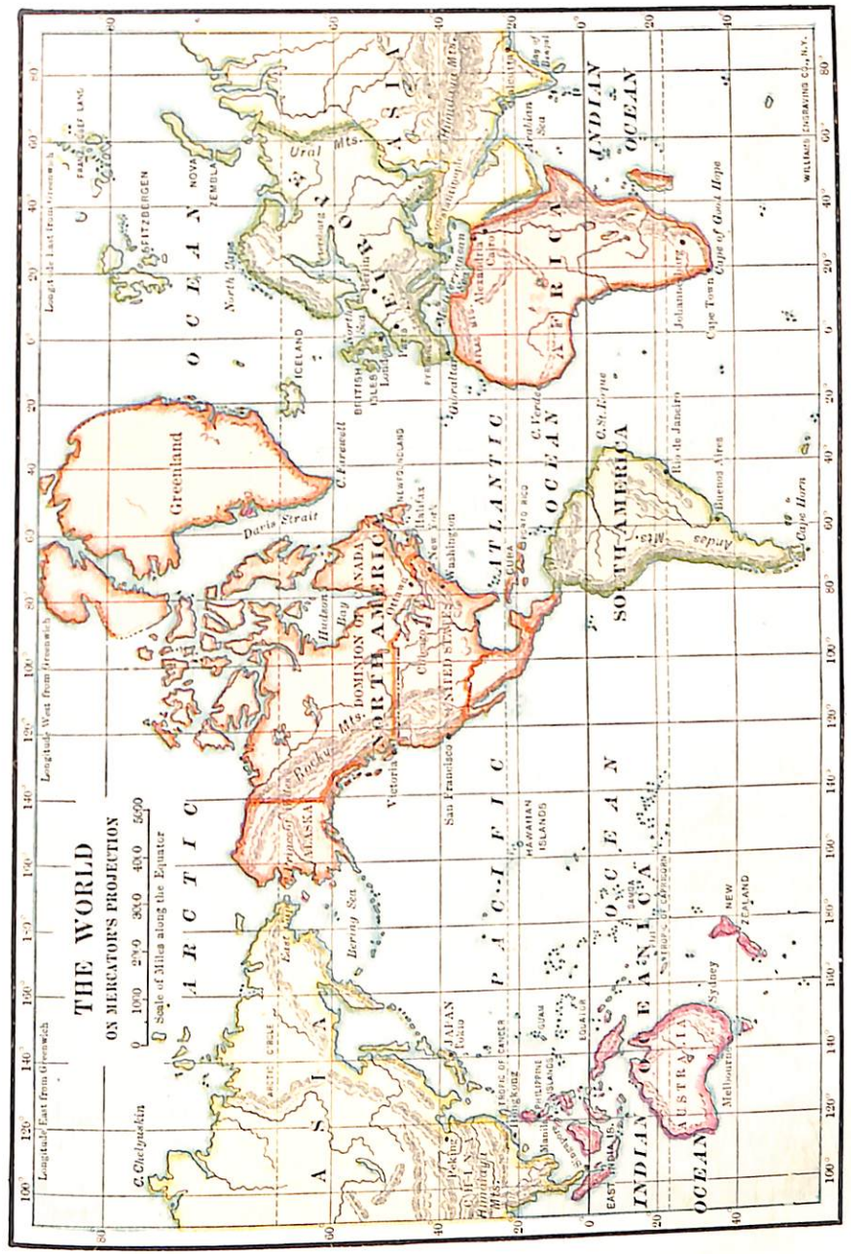
Lesson XXI

Land Masses of the Globe

God . . . laid the foundations of the earth, that it should not be removed forever. Ps. 104: 1-5.

Upon what day did the Creator cause the dry land to appear? Name in order the great divisions of land upon the earth. Upon which of these do you live? Which are north of the Equator? Which south? Which comprise the Old World? Which the New? What continents lie partly in the Frigid Zones? Which lie in the Torrid Zone? In Temperate Zones? What continent lies wholly in the Southern Hemisphere?

"As the earth came forth from the hand of its Maker, it was exceedingly beautiful. Its surface was diversified with mountains, hills, and plains, interspersed with noble rivers and lovely lakes; but the hills and mountains were not abrupt and rugged, abounding in terrific steeps and frightful chasms, as they now



do; the sharp, ragged edges of earth's rocky framework were buried beneath the fruitful soil, which everywhere produced a luxuriant growth of verdure. There were no loathsome swamps nor barren deserts. Graceful shrubs and delicate flowers greeted the eye at every turn. The heights were crowned with trees more majestic than any that now exist. The air, untainted by foul miasma, was clear and healthful. The entire landscape outvied in beauty the decorated grounds of the proudest palace."

The earth is man's home. We read, in the Scriptures, that it was the purpose of the Creator that our earth should be inhabited. "He created it not in vain, He formed it to be inhabited." And we read also that "the counsel of the Lord standeth forever, the thoughts of His heart to all generations."

The inhabitants of the land multiplied, and in due time were scattered abroad upon the face of the earth. You are familiar with the record. Some went one way, and some another, those who could understand one another's speech uniting in companies.

You will notice that the land surface of the earth is to a large extent connected. Were it not for a single break of about forty miles, a continuous land journey could be made across the continents, a distance greater than the circumference of the globe. Doubtless the people of those early times would never have been lost to one another had they not chosen to be lost to their Creator. But we are told that idolatry became well nigh universal, and therefore the Lord left the hardened transgressors to follow their own evil ways. At length it came to be true, in the long ago, that even in the most enlightened part of the earth, men knew very little of the world beyond their own countries. For hundreds of years the people of Europe and Asia knew scarcely anything about Africa, and nothing whatever about Australia and America. However, sometimes famine caused the people to journey from place to place. Again war drove them from the land of their birth, and scattered them in strange countries, and occasionally some undertook long trips for trade.

The earliest traders and explorers traveled always by land, and hence these journeys occupied many months and even years. But God had stated that "knowledge shall be increased," and that men should "run to and fro," and accordingly the time of awakening came at last. A spirit of adventure and discovery took possession of the minds of men.

The different nations of Europe, beginning to appreciate the possibilities of trade in the East, began to give thought to routes of travel. The productions of eastern lands had, for a long time, reached southern Europe by caravans. Merchandise was brought overland across the Isthmus of Suez, and shipped at Alexandria, on the coast of Egypt, for southern European ports.

After a time, the kings and leading men in the western countries of Europe conceived the idea of trying to find an easier way of conveying goods than overland by caravans. Portuguese sailors began to explore the African coast, which was almost in sight of the home land. At length Bartholomeu Dias succeeded, in 1486, in sailing around the cape at the south of Africa. He encountered such bad weather that he named the southern promontory the "Cape of Storms"; but when the king of Portugal heard of the discovery, he said, "No; it holds out so bright a promise of reaching India by sea, it shall be called the 'Cape of Good Hope.'"

About this time Christopher Columbus was eager to find a way to India across the Atlantic Ocean. He said that he would reach the East by sailing west. Columbus was an Italian, but as his country refused to entertain his proposals, he proceeded to Spain, and at length the Spanish monarch provided him with ships, and in 1492 Columbus crossed the Atlantic, and discovered the New World.

Another Italian navigator, named *Cabot,* who was living in England at that time, made a voyage across the Atlantic in an English ship, and discovered Newfoundland, off the coast of North America. In the same year, Vasco da Gama, sent out by Portugal to discover the sea route to India, rounded the

Cape of Good Hope, crossed the Indian Ocean, and finally reached the west coast of India in 1498.

Another century passed away, and then, in 1606, a Dutch writer described the discovery of "Terra Australis," the "Land of the South." In 1770, Captain Cook took possession of this island continent of Australia, in the name of George the Third, of England.

In our further study, we desire to review the facts of geography already studied in Books One and Two, and in addition, learn something of the great political divisions of each continent, and something of the peoples of all these different countries.

Questions

1. Study the grouping of the land masses, and bound each continent.
2. Compare the continents as to shape.
3. Define *mountain, mountain range, mountain system.*
4. Define *island, isthmus, peninsula, cape* and give prominent examples of each.
5. Trace the chain of primary highlands through the continents, and notice that they are arranged somewhat in the shape of a horseshoe.

Note Book Requirements

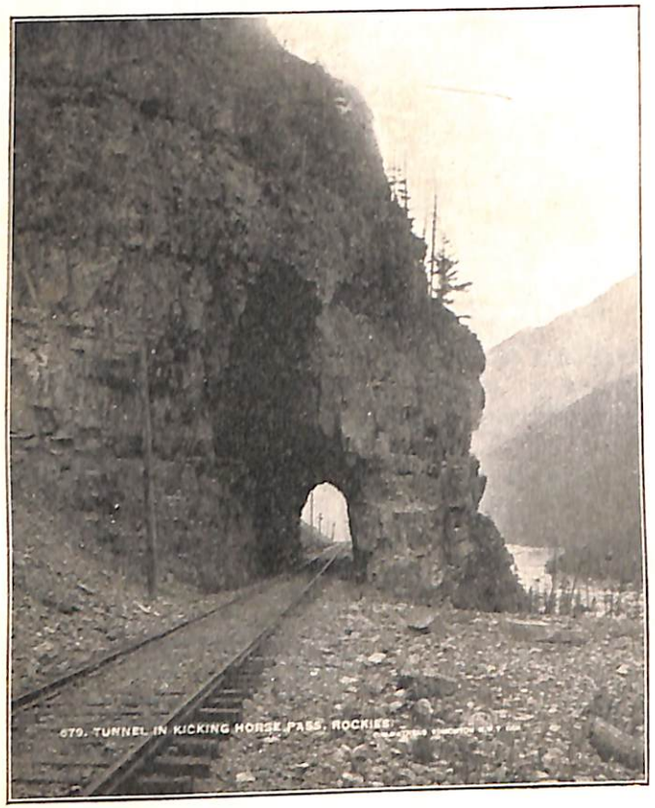
1. Upon Mercator's projection reproduce the principal highlands and lowlands, representing the highlands in black, and the lowlands in a soft color.
2. Locate by number upon your map all prominent land forms mentioned in your lesson.

Lesson XXII

Review Map Study on Physical North America

Position.— Bound the continent. In what hemisphere does it lie? What is its position as related to other continents? What is its position as related to the climate belts of the globe?

Coast Line.— Describe in a general way the coast line of North America, stating which coast is longest, which the most regular, which the most irregular, which is most navigable, and which has the greatest number of harbors. Name and locate the great ocean arms that wash the shores of North America. Locate four prominent peninsulas of the continent. Name three eastern capes, two western, and two northern capes of the continent. Name and locate prominent continental island groups. Name and locate at least four prominent islands. Bound each.



TUNNEL IN THE ROCKIES

Surface and Drainage.— Locate and describe the prominent highland region of the continent. Locate and describe the secondary highland region of the continent. Name the principal mountain systems of each highland region. Locate five prominent mountain peaks of the continent. Locate and describe the great lowland region of the continent. What is there on your map that indicates the line of the lowest land between the eastern and the western highland region of North America? Describe

the principal river system of the Great Central Lowland. Name seven other important rivers of North America. Why does the Mississippi River flow south, the Mackenzie River north, and the St. Lawrence in a nearly easterly direction? Why are the rivers flowing into the Mississippi from the west longer than those from the east? Why are the rivers more numerous on the east coast of North America than they are on the west?

Climate.— Through what heat belts does the continent extend? What ocean currents wash the shores of this continent? What is the effect of these currents on the climate of the Pacific coast of North America? On the climate of the Atlantic coast? Where on the continent is there the greatest rainfall? Where the least?

Requirement

Prepare a list of all proper names occurring in the lesson, divide into syllables, and accent, bringing to class for a spelling lesson.

Lesson XXIII

Review Map Study on Political North America

And hath made of one blood all nations of men for to dwell on all the face of the earth, and hath determined the times before appointed, and the bounds of their habitation. Acts 17: 26.

General.— Distinguish between a physical and a political map. What physical features often serve as boundary lines between states and countries? Who determines the boundaries of nations? Why? Acts 17: 27.

Countries.— Name and locate the principal political divisions of the continent of North America. Give the capital and largest city of each country.

Government.— What countries of North America are republics? By what European country is the Dominion of Canada governed? What language is spoken in Canada? By what river

are the English-speaking countries of North America separated from the Spanish-speaking countries? What small state in Central America is under the rule of Great Britain?

Cities.— Name and locate ten large inland cities of North America. Name and locate ten of the largest seaport cities. Name and locate the largest cities of the principal islands.

Note Book Requirements

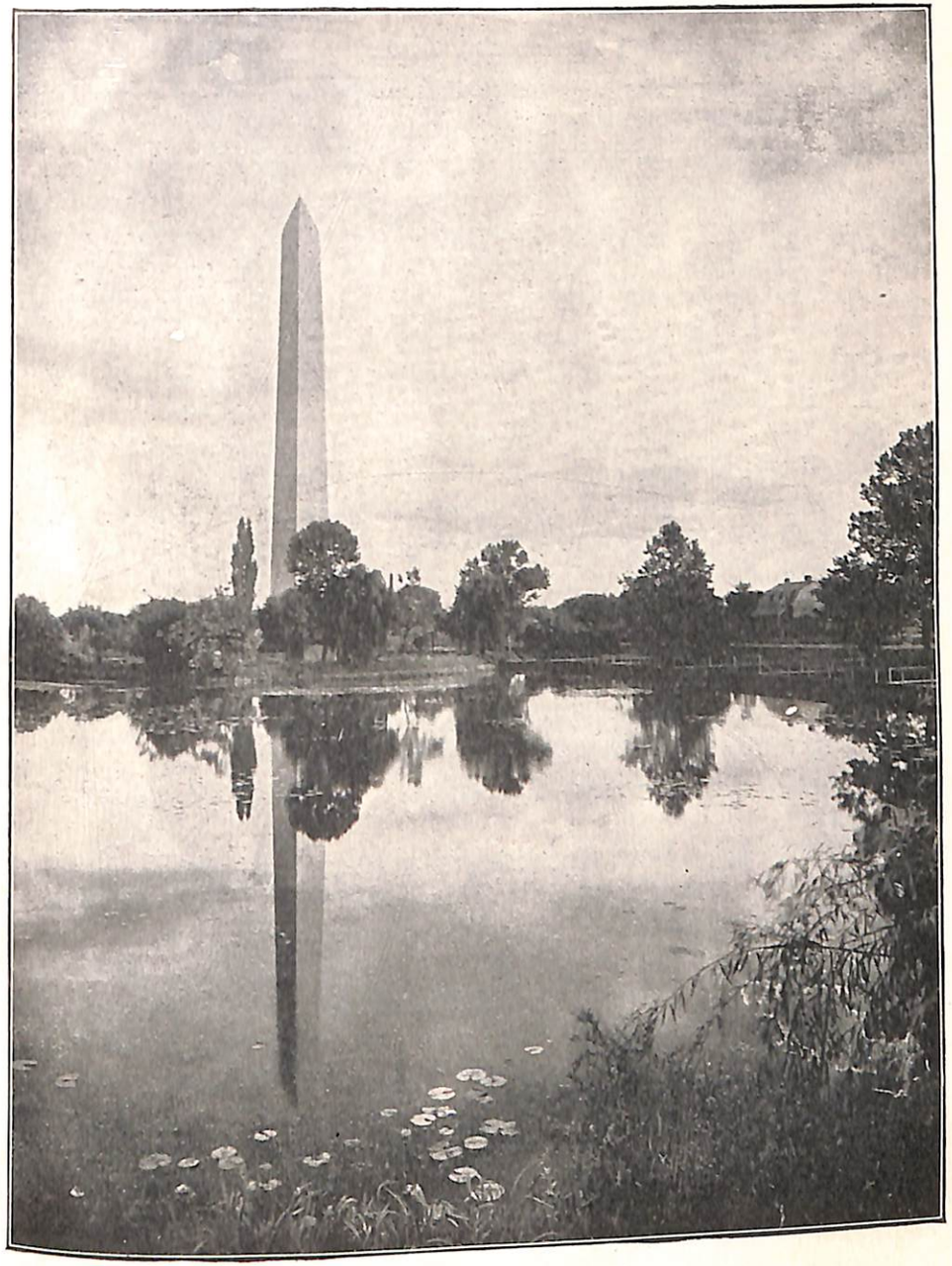
1. Trace the coast line of North America.
2. Show the proper degree of latitude or longitude of each parallel or meridian.
3. Trace the islands of North America, and name waters surrounding the same.
4. Trace the rivers, and indicate highland regions.
5. Trace the parallel that forms the boundary between the western part of the United States and the Dominion of Canada.
6. Trace the southern boundary of the United States from the Pacific Ocean to the Rio Grande.
7. Insert the boundary between Alaska and the Dominion of Canada.
8. Trace the southern boundary of Mexico; also the boundaries of Gautemala, Belize, Honduras, Salvador, Nicaragua, and Costa Rica.
9. Insert names of all political divisions, locating capitals and largest cities by number.
10. Color the map to show political divisions.

Lesson XXIV

The United States

That they should seek the Lord, if haply they might feel after Him, and find Him, though He be not far from every one of us. Acts 17: 27.

Map Study.— What position does the United States of America occupy in the North American continent? Bound it. Describe the principal highlands and lowlands of the country.



WASHINGTON MONUMENT

Point out the principal lakes and rivers. Locate the five chief slopes of the country. Compare the mountains of the western slope with the mountains of the eastern slope.

The Lord has a watch care over the nations. It is He who determines the bounds of their habitation, "that they should seek the Lord, if haply they might feel after Him, and find Him." "The times before appointed" for the rise of every nation are carefully remembered by the One who guides in the affairs of men. He was causing all things to work together for good when He led to the discovery and settlement of the New World. He directly guided in the establishment of the country which we now know as the United States of America, and whose rise prophecy foretold hundreds of years before.

Although discovered in the fifteenth century, it was not till the beginning of the seventeenth century that permanent settlements were made by Europeans upon the North American continent. Within the territory that was destined to become the United States of America, persecuted Protestants and Catholics alike sought refuge. Dissatisfied English Puritans, Dutch reformers, German and Swedish Protestants, French Huguenots,— these, and many more, fled from Europe to the New World, seeking homes where they might enjoy freedom of thought and worship.

It was to be a new world in more than one sense. Virgin forests and extensive agricultural areas, manufacturing facilities and an abundance of mineral wealth, were not so great an inducement to the people of even those congested countries whence they came, as were certain other privileges which they sought in this new land. More than all else, they longed for freedom from the religious persecutions which then prevailed in Europe. For this freedom they came to America.

All this religious persecution had been brought about because of the wrong principles which nearly all European governments at that time recognized and upheld,— the union of church and state, and the enforcing of the state religion. If the ruler, who

UNITED STATES
Scale of Miles.
0 50 100 200 600
Capitals of Countries
Capitals of States
Other Cities
DOMINION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
CUBA
BAHAMA ISLANDS
LOWER CALIFORNIA
Gulf of California
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W. VIRGINIA
PENNSYLVANIA
NEW YORK
VERMONT
N. HAMP.
MASS.
CONN.
R. I.
MAINE
N. JERSEY
DEL.
MD.
Salt Lake City
Denver
Santa Fe
Austin
Dallas
Galveston
San Antonio
Houston
New Orleans
Little Rock
Jefferson City
Topeka
Lincoln
Omaha
Des Moines
Springfield
Chicago
Milwaukee
Madison
Lansing
Detroit
Columbus
Cincinnati
Cleveland
Frankfort
Nashville
Atlanta
Montgomery
Jackson
Tallahassee
Jacksonville
Tampa
Raleigh
Richmond
Washington
Philadelphia
Harrisburg
Albany
Boston
Hartford
Concord
Augusta
Montpelier
Ottawa
Quebec
Montreal
Toronto
Winnipeg
Regina
Vancouver
Victoria
Seattle
Olympia
Portland
Salem
Boise
Helena
Butte
Bismarck
Fargo
Duluth
St. Paul
Minneapolis
Sioux City
Sioux Falls
Pierre
Deadwood
Cheyenne
Ogden
Carson City
Virginia
Sacramento
San Francisco
Los Angeles
San Diego
Phœnix
Tucson
Albuquerque
Grand Jc.
Leadville
Pueblo
Pikes Peak
Kansas City
St. Louis
Cairo
Memphis
Vicksburg
Mobile
Baton Rouge
Charleston
Savannah
Wilmington
Norfolk
Pittsburg
Buffalo
Rochester
Saratoga Sprs.
Toledo
Ft. Wayne
Peoria
Louisville
Mammoth Cave
Chattanooga
Columbia
Montpelier
Portland
Newport
Trenton
Camden
Atlantic City
Baltimore
Annapolis
Dover
Chesapeake Bay
C. Hatteras
C. Sable
Key West
Havana
Longitude 100° West from 95° Greenwich
THE M.-N.CO.

usually claimed to be the spiritual leader of the people, chanced to be a Catholic, then no favor was extended by that government to any religion except the Catholic. If, on the other hand, the ruler was a Protestant, persecution of Catholics was likely to prevail. How wrong was this, and how great was the misery resulting from the practice of such a principle!

The Lord had in mind the establishment of a new nation,— a nation to be the light of the world,— a nation through which He should prove to the world the successful working of the new and yet ever old and eternal principle of religious freedom.

Settlements were first made along the Atlantic seaboard. Here thirteen English colonies united their common interests, and became the nucleus for a new nation. It was in 1776 that the memorable document known as the Declaration of Independence was signed by representative men of these colonies. After a war known as the War of Independence, thirteen states were formed, and a union brought about that was to give to this country a united republican government, where church and state should be entirely separate.

The thirteen original states were New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Georgia.

A glance at the map will show that these thirteen states occupy but a small part of the entire original territory, which included all the land east of the Mississippi River except Florida; and this entire territory, as defined by the treaty of peace in 1783, was much less than the great area beyond, which was purchased or annexed during the succeeding years, and out of which great states were formed and added to the union.

Nearly all the vast region between the Mississippi River and the Rocky Mountains, except Texas, was bought from France in the year 1803.

The peninsula of Florida, together with a narrow strip of land along the Gulf of Mexico, was bought from Spain in 1819.

The great state of Texas entered the union in 1845. The Oregon country was added to the union one year later; and the great Mexican territory ceded in 1848 completed the expansion of the republic from shore to shore.

With an eastern coast facing Europe, and a western coast facing Asia, both of these coasts having excellent harbors; with wonderful resources in climate and soil; with a situation central for trade and communication with the rest of the world; having a government providing free education and maintaining separation of church and state; with a large and progressive immigration,— perhaps no other country has in all of these respects been so highly blessed and favored.

And why has the Lord thus favored this nation? Why is it that a population should be brought to this country, outnumbering the entire population of all the other North and South American countries when taken together? Why should the Lord bring to this country such a variety of races and people?

Questions

1. Why has the Lord an interest in the "times" and "bounds" of nations? Acts 17: 26, 27.
2. Was the rise of this particular nation prophesied? Rev. 13: 11. When was this?
3. In what century were the first permanent settlements made by Europeans upon the continent of North America?
4. State one chief cause of immigration to these early settlements in America.
5. Name certain religious bodies who sought refuge in the New World.
6. What were the thirteen original states?
7. Name the states that have since been formed and joined the union.
8. Enumerate a few of the resources of this country, and answer the last question in the last paragraph of the lesson.

Note Book Requirements

1. Trace the coast line, rivers, and lakes of the United States. (Do this very lightly with pen and ink.)

2. Show the Rocky, the Cascade, the Sierra Nevada, and the Appalachian Mountains.
3. Insert the boundaries and names of all the states and territories.
4. Color the states to indicate the grouping suggested in the following lessons.

Lesson XXV

The New England States

Map Study.— Name the New England States. How many are there? Which is the largest? Which is the smallest? Which state of the group has no seacoast? Name a lake bordering on this state. Locate other lakes in this group. Find two rivers that help to make state boundaries. Find Cape Cod and Cape Ann. Locate the Green Mountains and the White Mountains. Locate the capital and largest city of each state. What direction is this group of states from your home?

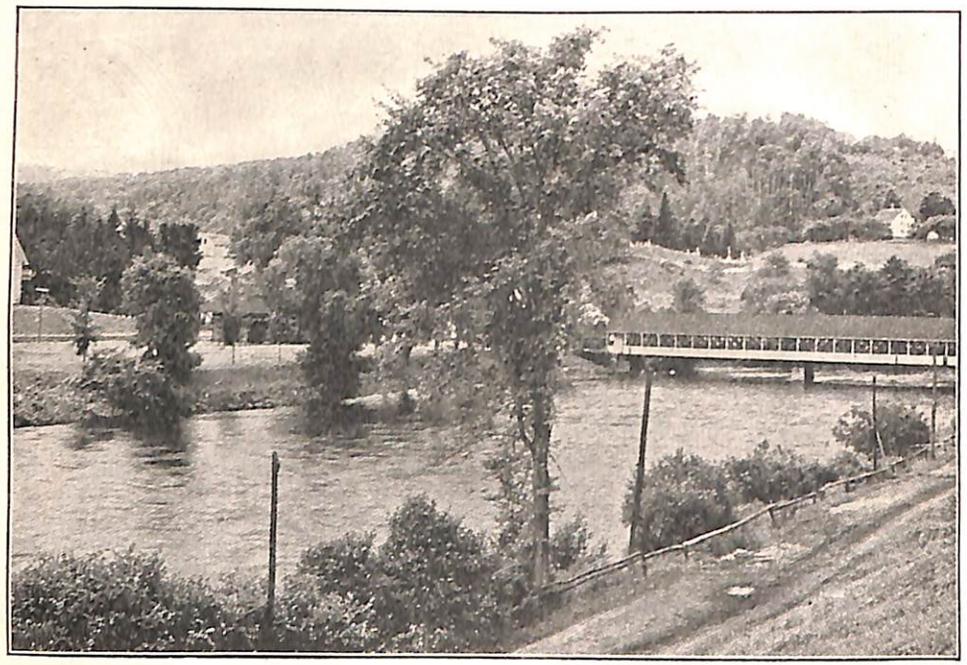
Early in the seventeenth century a company of English people known as the "Pilgrim Fathers" came from Europe to America in search of a place where they might enjoy freedom of religion. They came across the Atlantic to make homes in the New World which Columbus and others had discovered and somewhat explored more than a hundred years before.

It was in 1620 that the Pilgrim Fathers landed upon the rugged shores of that part of the North American continent which has ever since been known as New England. They made their first settlement at Plymouth. Other colonies followed. The settlement at Boston has grown into the city of Boston, the largest in this group of states, and fifth in size in the union.

The first settlers of New England were industrious and enterprising. Although they found many obstacles to surmount and many problems to face in this new country, they set out so

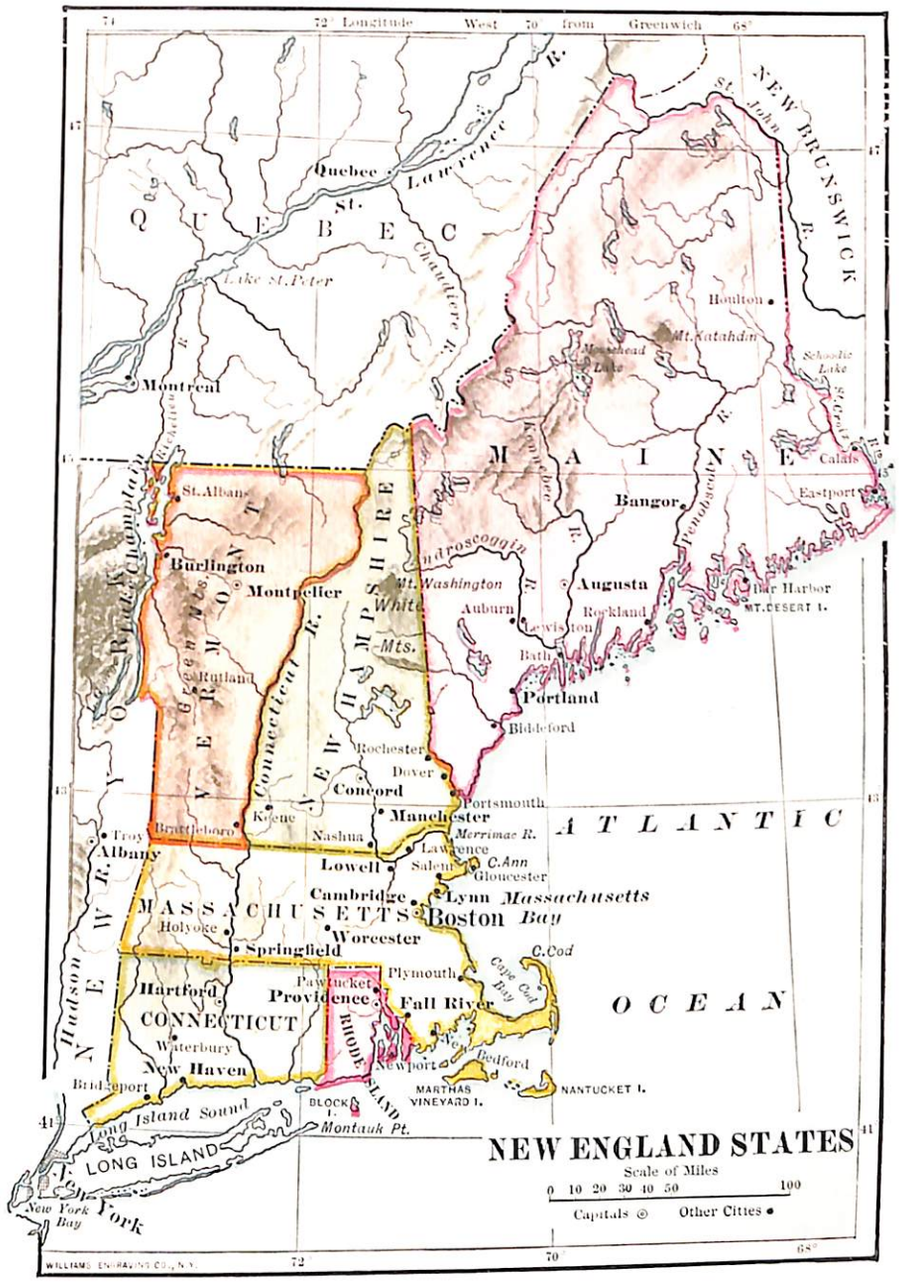
earnestly to overcome them, that they not only made comfortable homes for themselves and their children, but helped others who came later, until this rugged but beautiful country became the home of many thousands of busy people.

The surface of these states is traversed by the northern ranges of the Appalachians. The soil in general is gravelly and rocky, so that farming can not be carried on as extensively



NEW ENGLAND SCENERY

here as in other parts of the country. The valleys of the largest rivers are, however, productive; and hay, apples, potatoes, and various garden products are raised on the small farms. The farmers find such ready market for all they produce, that they can make a comfortable living on a very small farm. This is because there are large cities near, eager to secure food for their large population.



In the days of the early settlers, there were dense forests of pine, spruce, hemlock, birch, and other trees. Wherever the soil was fertile, the woods were cleared away and homes were built. But large sections in northern Maine, New Hampshire, and Vermont, as well as parts of the three states south of these, are still covered with timber. The cutting of this timber, and the floating of the great logs to the mills, provides employment for many men; and at the sawmills where the timber is stopped, employment is given to many others. In these mills, quantities of lumber are made ready for market. These sawmills sprang up along the rivers and near the coast, for manufacturing in this section is greatly aided by the abundance of available water power. Another important use of the forest trees is to provide wood pulp for the manufacture of paper; hence large cities in this section have grown up around the great paper mills. Holyoke is the greatest paper-making city in New England.

Then there are the rocks of New England. Especially valuable are the granite, the marble, and the slate, which are quarried in great quantities. In fact the supply of choice building stone is so great that it is estimated that one half the granite and marble used in the United States is taken from the New England quarries. These quarries, too, have generally been located near cities, or near the sea, where the stone may be sent away in ships. The largest marble quarries in the world are in Vermont. Rutland, a city of that state, is especially noted for the white, durable marble taken from its quarries.

In addition to the industries already mentioned, *fishing* was, from the first, an industry of no small importance. The names *Cape Cod*, *Halibut Point*, and *Bass Rock* indicate that various kinds of fish were found along the New England coast; and although now the fish are somewhat less abundant, still hundreds of vessels and thousands of men are engaged in catching and preparing for market the mackerel, halibut, cod, and other fish, large quantities of which are shipped from such ports as

Gloucester, a city on the Massachusetts coast famous for its fisheries.

Manufacturing facilities are so abundant, and the shipping facilities so excellent, that it pays to bring raw materials here to be manufactured. The chief manufactures are those of cotton, wool, leather, and metal, and include cotton and woolen cloth, boots and shoes, and brass goods; also paper goods, light hardware, fine machinery, clothing, silk, and rubber goods.

Although the numerous waterfalls of the country afford excellent manufacturing power, so extensive and profitable has the manufacture of certain articles become that it is now profitable to use steam power for manufacturing. Coal for this purpose is brought to New England chiefly by sea from the ports of the Chesapeake and Delaware bays.

The New England States produce more cotton and woolen goods, and more boots and shoes, than all the rest of the United States taken as a whole.

Among the large cities manufacturing cotton and woolen cloth are Manchester and Nashua, located at falls on the Merrimac River; also Lewiston in Maine. Lynn is famous for its manufacture of boots and shoes, and Providence for its jewelry. Providence is famous also as the city of Roger Williams, who in early colonial times was the great apostle of religious liberty in New England. He founded the city of Providence, believing that the providence of God had protected him during persecution; and he made it the asylum of persecuted colonists.

Boston is the commercial center for the New England group. Its harbor at the head of Massachusetts Bay is of great size and depth. Nearly the whole steam railway system of this section, in addition to many electric lines, radiates from this city. Boston is also a noted educational center. Because of its numerous schools, libraries, colleges, and the great number of noted musicians, artists, and authors who have lived in or near the city, the citizens often call Boston the "Athens of America."

Because the country favors manufacturing rather than agriculture, more than half the population of New England is brought together in large cities; and although the natural beauties of this section are scarcely surpassed anywhere in the world, there are many men and women confined day after day in the noisy factories, offices, and stores, shut in with their work, except for an occasional vacation. The vacation usually comes in summer, and is a great treat, for then all New England is one beautiful park. The wooded mountains, the green valleys, the quiet rivers, the silvery lakes, the rocky seacoast, offer such attractions that tens of thousands go away from the cities every summer to enjoy the vacation of a week or more.

Unfortunate it is that so many are deprived of the advantages of the beautiful country scenery, the invigorating, wholesome air of God's great, beautiful out-of-doors. The boys and girls in the country have much for which to be thankful. How many children there are in the crowded cities who have not even a spot of green grass to set their feet upon! If they could be educated in the country, amid the beauty, peace, and purity of nature, it would seem to them the place nearest heaven. Do you know why?

write

Questions

1. Who were the first settlers of New England?
2. At what place and when did they make their first settlement?
3. What can you say of the character of the early settlers of that section?
4. Describe the soil and surface of the New England States.
5. Name the principal industries of that section.
6. Mention articles manufactured in the factories of New England.
7. Name and locate four large manufacturing cities.
8. Why was the city of Providence so called? For what is it noted as a manufacturing city?
9. For what is Boston noted?
10. What can you say of the natural beauties of this section?

Lesson XXVI

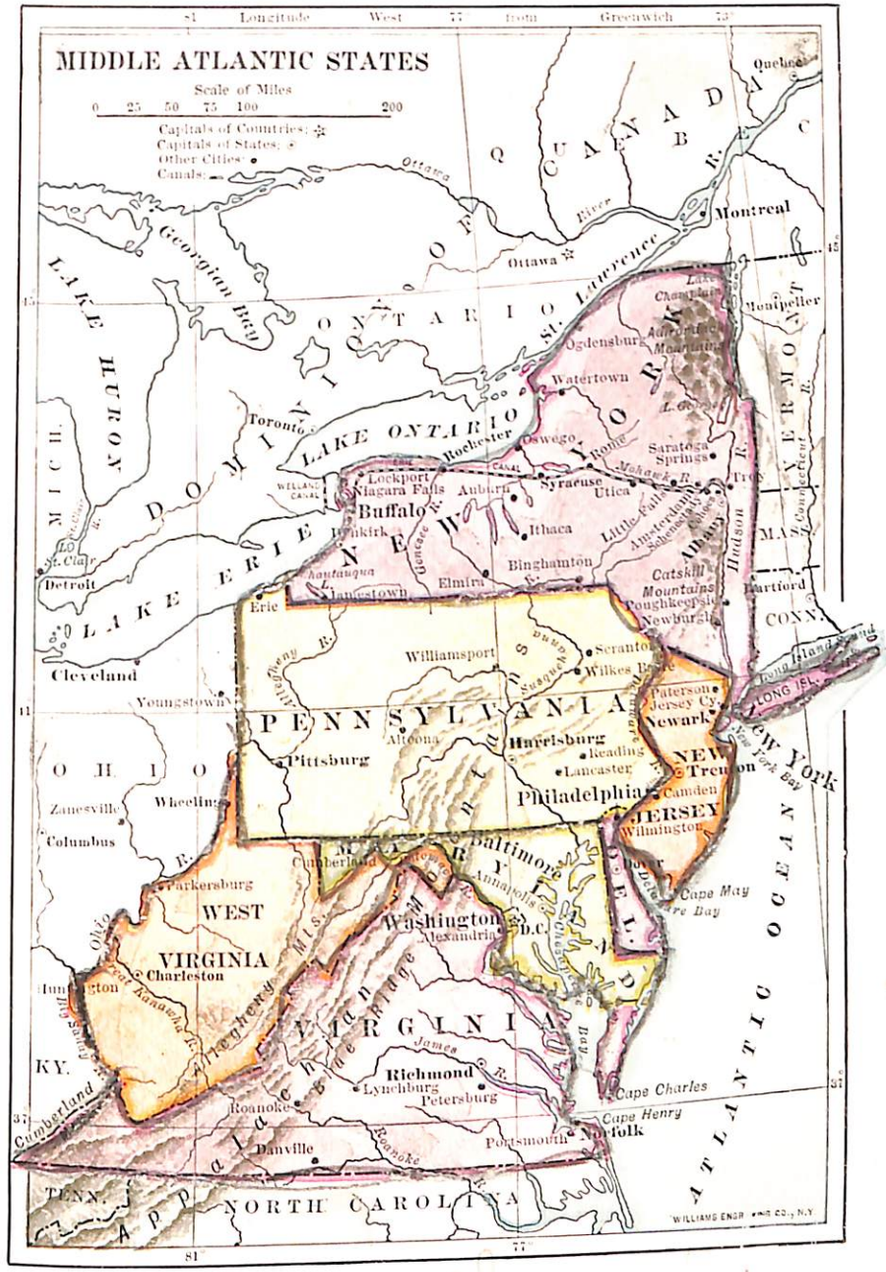
The Middle Atlantic States

Map Study.— Name the states of this group. Which is farthest south? Which farthest north? East? West? Which of these states border on the Atlantic Ocean? Which do not? Which is the smallest state in this group? Name the chief rivers of these states, and tell where they are. Locate also the chief mountain range. Find and name the capital of each state. Locate all the other cities mentioned in the lesson.

The seven states here grouped together are sometimes placed with the group previously studied, and the two groups together are then called the *Northeastern States*. And sometimes they are grouped with the great states lying directly west, but from which they are separated by the parallel ranges of the Appalachian Mountains which cross the states of this section.

This mountain barrier of eastern North America stretches along with only one considerable break in its length, and in places is some three hundred miles in width. A mantle of primeval forest, with a singularly dense undergrowth, helped, in the early days, to make these mountains a nearly impassable barrier. The rivers flowing down their eastern slopes were not navigable, rapids and waterfalls hindering travel by boat. Thus, having no easy access to the interior, the early settlers established colonies along the seaboard country, and lived there for more than a generation before very much was known of the region beyond.

In New England the Atlantic plain is only from fifty to eighty miles wide; but it gradually broadens as it continues southward, thus furnishing a wider area for settlement in the South than in the North. Furthermore, the northern region is covered with a heavy deposit of boulders, which must be removed at the cost of great labor before the land is ready for



draw this map

cultivation. This is not the case farther south. There the larger open areas invite agriculture, and the planters were led to take up as large tracts as possible.

The climate of the coast region is mild and moist, because of nearness to the ocean, while the Allegheny Mountains partially shut out the cold north winds. Here the live oak flourishes and wears its green leaves all the year.

The fertile soils brought down by the rivers are very rich along the coast. These low, rich plains have become, in later years, a great region of truck farming, where many vegetables and small fruits are raised for the Northern market. Potatoes, radishes, onions, lettuce, celery, tomatoes, sweet potatoes, and strawberries and other small fruits, are raised in large quantities, and shipped to the North.

The coast cities are important seaports, connected not only by ocean-going vessels, but by a line of inshore traffic. Important cities have grown up at the head of river navigation on all the larger streams. Among these are the cities of Troy and Albany, Philadelphia, Baltimore, and Richmond. All the principal cities of these states are now connected by rail.

The Hudson Valley is a very important traffic route, both by water and by railway. Large steamships can go up the Hudson as far as the Mohawk River. From Albany, the head of navigation on the Hudson, a canal is carried to the foot of Lake Champlain. This is an easy means of transport for lumber, stone, iron ore, and slate, from the Adirondacks, Vermont, and Canada. One of the largest lumberyards in the United States is at Albany, where this canal connects with the Hudson.

From Albany, along the valley of the Mohawk, across the plain of northern New York to Buffalo, extends the famous Erie Canal. It is 363 miles long, and cost $10,000,000 when first built, but much more has been spent on it since. This canal is especially important, connecting western New York and the region about the Great Lakes with the Atlantic Ocean, and furnishing a great highway for commerce.

About the time the Erie Canal was finished, the locomotive was invented, and railroads began to be built. One of the first was the New York Central, running from New York to Buffalo. It follows the Hudson River to Albany, then takes the same westward course as the Erie Canal. Other railroads crossing the Alleghenies to the west also carry quantities of goods back and

MADISON SQUARE, NEW YORK CITY

forth; but shipping by the Hudson River is so much easier and cheaper that it naturally gains the bulk of the western trade, and the surplus agricultural products of the Middle West and the Lake States find their way by the Hudson Valley to New York City, and thence to Europe.

Because of all this commerce and trade, New York City has become the leading seaport of the United States, about one half of the imports and exports of the country passing through New York Harbor. Because of these unusual advantages for shipping, thousands of factories have been located in this section, and in them are made almost all kinds of manufactured articles that are used.

Probably one of the greatest manufacturing industries in this section is the making of cloth. The refining of petroleum is one of the important industries in Jersey City and in Brooklyn.

Petroleum is a product of this region, and from it kerosene is manufactured. Large quantities of iron and steel goods are manufactured in this section.

The products of Pennsylvania and New Jersey, such as fruit, lumber, iron, coal, and oil, together with the manufacture of iron and other goods, have helped to make Philadelphia a great city. This port, like New York, has much foreign commerce. All this commerce and manufacturing keeps thousands of men and women busy. New York is the second largest city on the globe, and Philadelphia is the third city in the union in population.

Washington, the national capital, is said to be the most beautiful city in the United States. It was planned as a large capital city before it was built. It has broad, straight streets and

THOMAS CIRCLE, WASHINGTON, D. C.

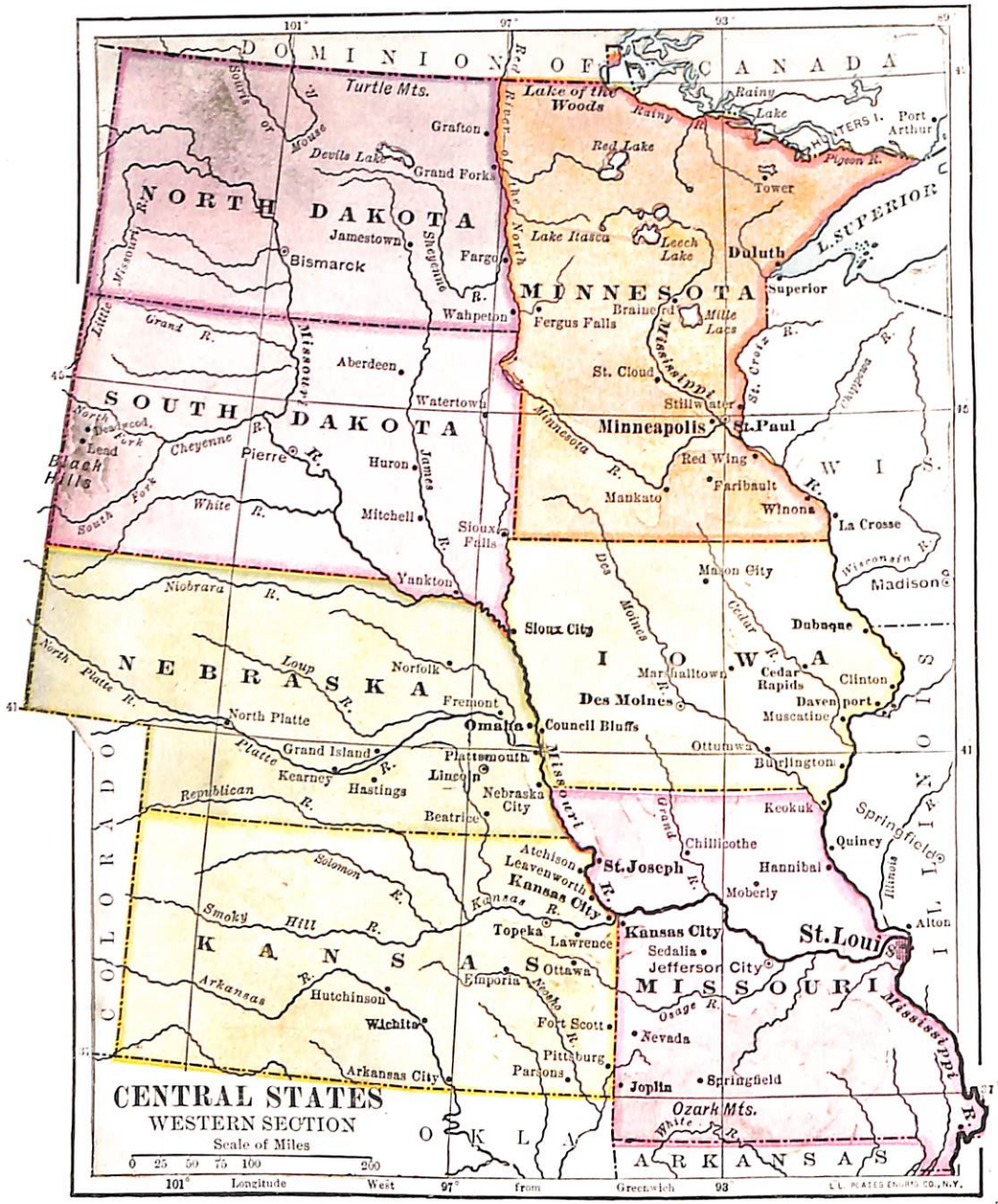
avenues, and many extensive parks. These are shaded with fine trees, and decorated with statues and monuments. The city has but little commerce, and no manufacturing other than government printing. It has grown up simply as a national capital. The president of the United States lives in Washington, as well as the members of the cabinet, and foreign ministers who come to our country from all the nations of the earth to represent their governments and to look after the interests of their people. The senators and representatives meet in the capitol, and Congress is in session for several months of each year. Here the laws of the republic are made.

Questions

1. Describe the coast line of the Middle Atlantic States.
2. Describe the Atlantic plain in this section, and compare with the Atlantic slope in the group previously studied.
3. What can you say of the rivers of this region? Of the mountains?
4. What can you say of the soil? What of the climate?
5. Discuss the industries of this section.
6. Name some of the crops raised in this group.
7. What are the chief manufactures?
8. Why is the Hudson Valley a very important traffic route?
9. Through what city of this group does half the commerce of the United States pass?
10. Name other cities having important foreign commerce.
11. Who founded Philadelphia? and what is the meaning of the name?
12. What can you say of Washington, D. C.?

Requirements

1. Draw each of the states in this group from memory, and locate the capital city. Find out other facts about the cities mentioned in your lesson.
2. Sketch the state of New York, and with a red pencil show the Erie Canal.


CENTRAL STATES
WESTERN SECTION
Scale of Miles
0 25 50 75 100 200
DOMINION OF CANADA
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
MINNESOTA
IOWA
MISSOURI
WIS.
ILLINOIS
COLORADO
OKLA
ARKANSAS
Turtle Mts.
Lake of the Woods
Red Lake
Lake Itasca
Leech Lake
Mille Lacs
L. SUPERIOR
Duluth
Superior
Minneapolis
St. Paul
Bismarck
Jamestown
Fargo
Grafton
Grand Forks
Devils Lake
Fergus Falls
Brainerd
St. Cloud
Stillwater
Red Wing
Faribault
Winona
La Crosse
Mankato
Watertown
Aberdeen
Pierre
Huron
Mitchell
Sioux Falls
Yankton
Sioux City
Mason City
Dubuque
Madison
Cedar Rapids
Clinton
Davenport
Des Moines
Marshalltown
Muscatine
Ottumwa
Burlington
Keokuk
Quincy
Hannibal
Moberly
Chillicothe
Springfield
Alton
St. Louis
Kansas City
Sedalia
Jefferson City
Topeka
Lawrence
Ottawa
Emporia
Fort Scott
Nevada
Pittsburg
Parsons
Joplin
Springfield
Arkansas City
Wichita
Hutchinson
Atchison
Leavenworth
St. Joseph
Nebraska City
Omaha
Council Bluffs
Fremont
Norfolk
North Platte
Grand Island
Kearney
Hastings
Plattsmouth
Lincoln
Beatrice
Black Hills
Lead
Ozark Mts.
Longitude West from Greenwich
L.L. PLATES ENGR'G CO., N.Y.

CENTRAL STATES
EASTERN SECTION
Scale of Miles
0 25 50 75 100 200
Capitals of States ⊙ Other Cities ∘
DOMINION OF CANADA
MINN.
LAKE SUPERIOR
ISLE ROYALE
MICHIGAN
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
WISCONSIN
IOWA
ILLINOIS
INDIANA
OHIO
KENTUCKY
TENNESSEE
WEST VIRGINIA
VIRGINIA
N. CAR.
ONTARIO
L. ONT.
N.Y.
PENN.
Georgian Bay
Port Arthur
Houghton
Calumet
Marquette
Ishpeming
Superior
Ashland
Sault Ste. Marie
Cheboygan
Alpena
Marinette
Menominee
Wausau
Eau Claire
Green Bay
Appleton
Oshkosh
Manitowoc
Sheboygan
Fond du Lac
Winona
La Crosse
Watertown
Madison
Janesville
Milwaukee
Racine
Grand Rapids
Muskegon
Manistee
West Bay City
Bay City
Saginaw
Port Huron
Flint
Lansing
Detroit
Battle Creek
Kalamazoo
Jackson
Ann Arbor
Adrian
Toledo
Dubuque
Freeport
Rockford
Evanston
Elgin
Oakpark
Aurora
Joliet
Chicago
Elkhart
Goshen
South Bend
Michigan City
Hammond
Fort Wayne
Davenport
Moline
Rock Island
La Salle
Streator
Ottawa
Kankakee
Galesburg
Peoria
Bloomington
Danville
Decatur
Springfield
Jacksonville
Quincy
Keokuk
Hannibal
Alton
St. Louis
East St. Louis
Belleville
Logansport
Marion
Lafayette
Muncie
Anderson
Richmond
Indianapolis
Terre Haute
Lima
Mansfield
Columbus
Springfield
Dayton
Hamilton
Cincinnati
Portsmouth
Newport
Covington
Madison
Jeffersonville
New Albany
Evansville
Louisville
Frankfort
Lexington
Owensboro
Henderson
Paducah
Cairo
New Madrid
Bowling Green
Nashville
Middlesboro
Knoxville
Cleveland
Youngstown
Akron
Canton
Massillon
East Liverpool
Steubenville
Wheeling
Zanesville
Marietta
Chillicothe
Parkersburg
Ironton
Huntington
Charleston
Erie
Longitude West from Greenwich

monday

Lesson XXVII

The Central States

Map Study.— Name the states in this group. Which of these border on the Great Lakes? Which do not? Name the rivers of this section that help to form state boundaries. Study the location of large cities. Find Chicago. Locate two large cities on the Ohio River, three on the Missouri River, and four on the Mississippi. Find and name the capital city of each state in this group.

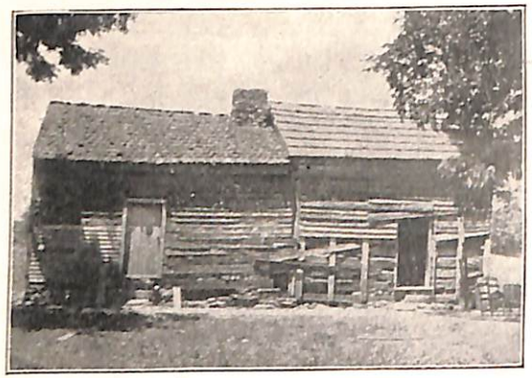
For one hundred and fifty years, the American colonies made no permanent settlements beyond the Alleghenies. But at last they climbed the mountains, and descended to the plains below. Great stretches of beautiful level or rolling land beckoned them on. Large tracts of treeless country, covered in summer with rich wild grass and made bright with thousands of flowers, lay before them.

These prairies were at that time the favorite hunting grounds of the American Indians. They were dotted over with ponds, which, in season, were covered with wild geese and ducks. Herds of deer and American bisons found pasture in this section. The Indians depended largely for food upon their regular hunting seasons, and the early white explorers and settlers supplied themselves in the same way.

The British government had encouraged the keeping of this western country as a reserve for the fur trade, and it was not until the separation of the colonies from the mother country that the pioneers crossed the Appalachian barrier, and made homes in the great prairie region now occupied by the states of this group.

In these early days, no railroads had yet been built. There were few wagon roads. The country had been explored by means of its great rivers and lakes, and these now became a highway for travel. Some of the early settlers went westward by way of Lakes Erie, Huron, and Michigan, and others by

way of the Ohio, Mississippi, and Illinois rivers. These latter loaded their household goods on flatboats or steamboats at Pittsburg, Pennsylvania, passed slowly down the Ohio River to its mouth, and then up the Mississippi and Illinois to some river town where they could secure teams to carry their goods across the country to the place of settlement.



LOG CABIN IN WHICH ABRAHAM LINCOLN LIVED

These early settlers built their log houses near streams, or in the strips of timber that bordered them, paying little attention to the prairies except for hunting and pasture. In those early days, the produce of their farms provided for their immediate needs only, there being no roads, and no good market for grain and other agricultural products.

But the soil of the prairies was deep and rich, the climate favorable, and except in the extreme western part of this section, the rainfall was ample, so that the farmers soon recognized the natural agricultural advantages.

After 1850, when railroads began to be built across the prairies, the country was gradually broken up by the plows of farmers, and grain began to be raised for shipment; and now, through the invention of improved agricultural implements, this has become one of the great food-producing regions of the world.

Instead of the waving prairie grass, there are now seen great rustling fields of corn, green meadows, and yellow fields of wheat and oats as they ripen in the summer sun. Dotted here and there are groves and orchards, near which nestle farmhouses and barns; and tall windmills, towering above the tree tops, are busy pumping water for the cattle. In the distance

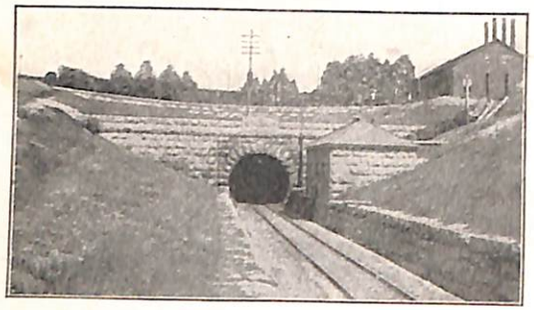
are seen the church spires of a village, the tall grain elevators; and a railroad train moving across the country is perhaps carrying the produce of the prairies to distant markets. At the present time, five sixths of the wheat, corn, oats, hay, and potatoes raised in the United States comes from this section.

Extensive forests and rich mineral deposits add to the resources of this group of states. In its forest regions lumbering is an important industry, the pine belt of the Great Lakes being one of the great timber-producing regions of the union. The lumber camps on the branches of the upper Mississippi, and especially in northern Wisconsin and Minnesota, are scenes of busy activity during the short, cold days of the long winter months; and the sawmills lower down the streams are kept very busy in summer and fall, sawing the logs and stacking the lumber. Many logs are worked up in the great sawmills at Minneapolis.

From the sawmills, the railroads distribute great amounts of lumber to the cities and villages of the wide prairies, where immense quantities are used in building houses, barns, bridges, fences, and many other things.

A WHEAT RANCH

The manufactures of this group are principally those that utilize the raw material produced in this section, chief of which are food products and lumber. All the states in this group are heavy producers of grain and cattle, and hence flour and meat rank first among food products.



TUNNEL UNDER ST. CLAIR RIVER, PORT HURON, MICHIGAN

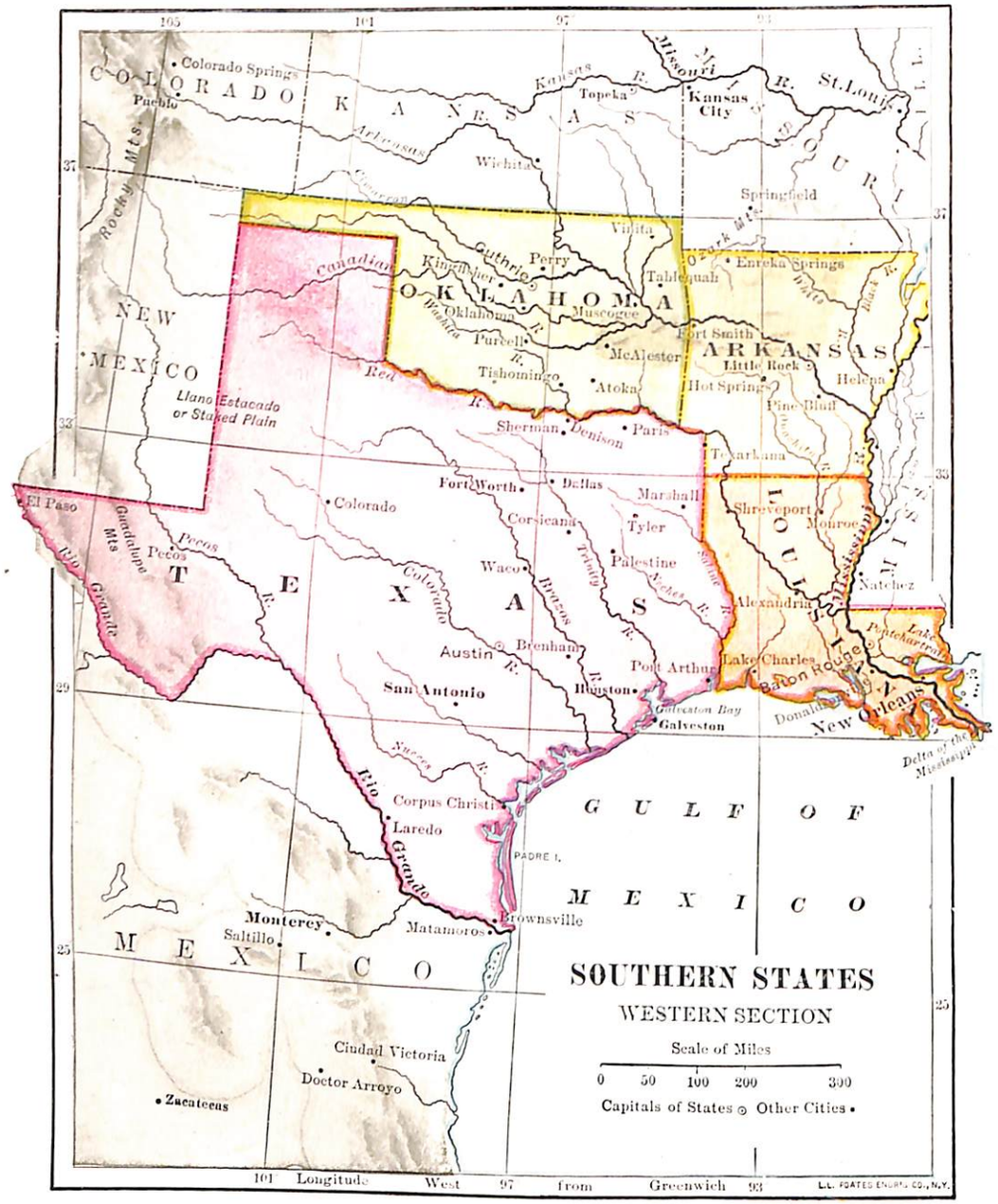
Illinois is in the heart of the corn, wheat, and stock-raising region; and as coal fields underlie nearly the entire state of Illinois, Chicago has become a great manufacturing center. It is also an important commercial city. The smooth surface of the country being covered with a network of railroads, raw materials are easily collected and carried to manufacturing centers.

Questions

1. When were permanent settlements first made west of the Alleghenies?
2. Describe this section as to surface and vegetation.
3. For what purpose only was this region at first thought to be valuable? Why?
4. What agricultural advantages do the Central States have?
5. Name the chief agricultural products.
6. How do railways encourage agriculture in these states?
7. What are grain elevators?
8. What can you say of lumbering as an industry in this section?
9. What are the manufactures of this group?
10. In which state are extensive coal fields found?
11. Explain why Chicago is a commercial and manufacturing city.

Requirement

On an outline map of the Central States, write the names of the products. Locate the capital city of each state. Collect illustrations of industries and products.


SOUTHERN STATES
WESTERN SECTION
Scale of Miles
0 50 100 200 300
Capitals of States ⊙ Other Cities •
Longitude West from Greenwich
COLORADO
KANSAS
OKLAHOMA
NEW MEXICO
TEXAS
ARKANSAS
LOUISIANA
MISSOURI
ILLINOIS
MEXICO
GULF OF MEXICO
Colorado Springs
Pueblo
Topeka
Kansas City
St. Louis
Springfield
Wichita
Vinita
Perry
Guthrie
Kingfisher
Oklahoma
Muscogee
Tahlequah
Eureka Springs
Fort Smith
McAlester
Little Rock
Hot Springs
Pine Bluff
Helena
Tishomingo
Atoka
Sherman
Denison
Paris
Texarkana
Fort Worth
Dallas
Marshall
Shreveport
Monroe
Natchez
Colorado
Corsicana
Tyler
Palestine
Waco
Austin
Brenham
Houston
Port Arthur
Lake Charles
Alexandria
Baton Rouge
New Orleans
Galveston
San Antonio
El Paso
Corpus Christi
Laredo
Brownsville
Matamoros
Monterey
Saltillo
Ciudad Victoria
Doctor Arroyo
Zacatecas
Llano Estacado or Staked Plain
Rocky Mts.
Canadian R.
Red R.
Arkansas R.
Missouri R.
Mississippi R.
Pecos R.
Rio Grande
Brazos R.
Trinity R.
Colorado R.
Nueces R.
Padre I.
Galveston Bay
Delta of the Mississippi
L. Pontchartrain
L. Borgne
Donaldsonville
Guadalupe Mts.
Ouachita R.
Black R.
Yazoo R.
Tombigbee R.
Alabama R.
Pearl R.
Big Black R.
Washita R.
Kiamichi R.
Sabine R.
Neches R.
Ohio R.
Cumberland R.
Tennessee R.
Wabash R.
Cairo

SOUTHERN STATES
EASTERN SECTION
Scale of Miles
0 50 100 200 300
Capitals of States ⊙ Other Cities •
Longitude West from Greenwich
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
FLORIDA
VIRGINIA
WEST VIRGINIA
KENTUCKY
INDIANA
OHIO
ILLINOIS
GULF OF MEXICO
ATLANTIC OCEAN
Cincinnati
Louisville
Evansville
Nashville
Clarksville
Knoxville
Bristol
Richmond
Norfolk
Greensboro
Durham
Raleigh
Winston-Salem
Asheville
Charlotte
Newbern
Wilmington
Cape Fear
Cape Hatteras
Memphis
Jackson
Columbia
Chattanooga
Florence
Decatur
Huntsville
Gainesville
Athens
Atlanta
Augusta
Aiken
Greenville
Columbia
Georgetown
Charleston
Beaufort
Savannah
Aberdeen
Columbus
Greenville
Birmingham
Anniston
Tuscaloosa
Bessemer
Selma
Montgomery
Macon
Americus
Eufaula
Meridian
Vicksburg
Natchez
Baton Rouge
Mobile
New Orleans
Pensacola
Tallahassee
Thomasville
Brunswick
Jacksonville
St. Augustine
Palatka
Ocala
Tampa
Miami
Key West
Havana
CUBA
BAHAMA IS.
Florida Strait
Cape Canaveral
Cape Sable
Cape San Blas
Apalachee Bay
Tampa Bay
Lake Okeechobee
The Everglades
FLORIDA KEYS
Delta of the Mississippi
L. Pontchartrain
Tombigbee R.
Alabama R.
Chattahoochee R.
Flint R.
Ogeechee R.
Savannah R.
St. Marys R.
Ohio R.
Cumberland R.
Tennessee R.
Wabash R.
Cairo

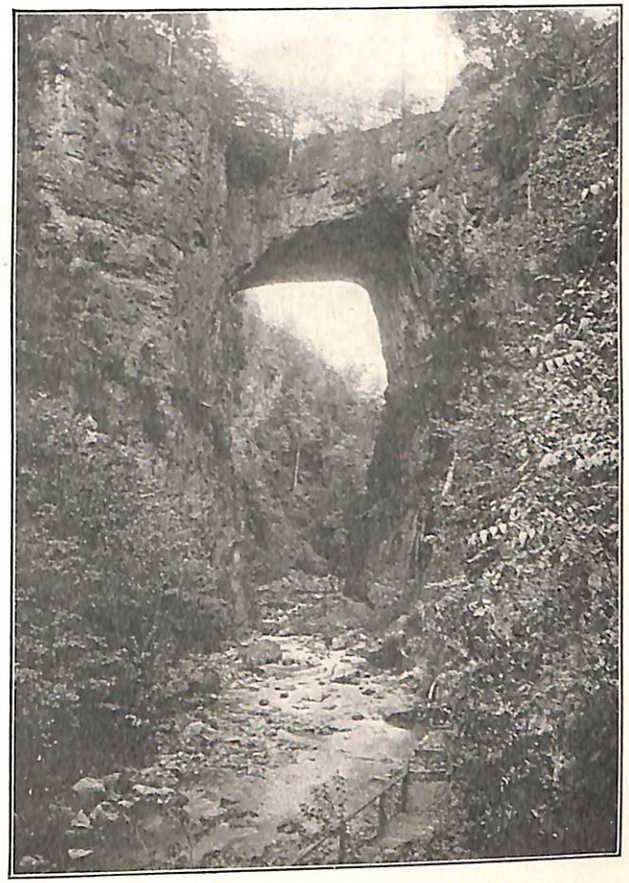
Lesson XXVIII

The Southern States

Map Study.— Name the states of this group that border on the Atlantic Ocean. On the Gulf of Mexico. Name the states of this section that have no seacoast. Which is the most western state of the group? Which the most southern? Across which states does the Appalachian range extend? Locate the Ozark Mountains. Find and name the capital of each state in the group.

This part of the United States is mainly a great region of plains. The surface is rugged only near the Appalachian and the Ozark Mountains.

In the northern portion of this section, especially in the valleys of these mountains, there are forests of oak, hickory, ash, and poplar. From Virginia southward, through the Carolinas and Georgia, and far south into Florida, the sandy lands are rich in turpentine woods;



NATURAL BRIDGE IN VIRGINIA

and the coast cities, such as Charleston, Savannah, and Jacksonville, are ports for its shipment.

Near the coast there is much low, fertile land; and along the Mississippi River there are broad, rich flood plains, protected from the river floods by banks called *levees*.

Long, hot summers, and short, temperate winters prevail over nearly the whole of this section. Although snow falls in every state in the group, it soon melts, and there is plenty of rain everywhere excepting in parts of western Texas and Oklahoma. Hence agriculture is the great industry.

TRANSPORTATION OF COTTON BY RAIL

Cotton is by far the most important crop, one fourth of all the farm land being devoted to its cultivation. Indeed, this is the world's greatest cotton-producing region. The principal cotton belt lies about one hundred miles from the coast, and stretches from Texas to North Carolina. But the finest cotton, that which possesses a tough and long fiber, comes from the sea islands along the Atlantic coast.

Corn is grown throughout the Southern States except the extreme west, and, with sweet potatoes, is the main food crop. In the northern part some wheat is raised, and much tobacco. This last crop is a great curse to the country, and it is to be regretted that so much good land is given to the culture of this poisonous weed.

South of the cotton belt the leading crops are sugar, corn, rice, and oranges. The peach crop of this section is also large. Fine horses are raised in the northern part of this group, and many cattle in the west.

Coal is extensively mined in the Appalachian and Ozark regions, and the southern end of the Appalachians has become a great iron-mining district. There are also valuable quarries of marble and granite in northern Georgia.

Formerly nearly all the labor in the Southern States was done by Negro slaves who had been imported from Africa. They could do farm work, but were not trained to use machinery. Hence nearly all the manufactured goods needed were brought from the North, or from abroad, in exchange for raw cotton. Now, however, since the Negroes are freed, attention has been turned to manufacturing and mining.

PALISADES ON THE MISSISSIPPI RIVER

The manufacture of cotton cloth is rapidly increasing in the South, especially in the eastern part of that section; and the extraction of oil from cottonseed has become an important industry. Sugar is made in the Mississippi delta. Iron and steel are manufactured in the iron-mining regions. There are many sawmills in the forests, and turpentine distilleries in the great pineries of the Southeast.

The coast of nearly the whole section is fringed with barrier beaches, and many of the inlets are narrow, and obstructed by shifting bars. In consequence, foreign commerce has not been greatly developed, though much cotton, and some grain, coal, and lumber are exported, and there is an active coast trade by small vessels.

Key West, the most southerly city in the union, exports sponges. This city is situated upon one of the coral islands in the warm, shallow water just south of the Florida peninsula. St. Augustine is a favorite winter resort upon the peninsula. It is the oldest town in the United States.

The Southern States contain about one fourth of all the people in the country. There are not many foreigners, but about one third of the population are Negroes, and in several of the states they are more numerous than the white population. These Negroes are mostly the descendants of those who were freed from slavery by the Civil War.

The South suffered much during the war. Armies marched back and forth, destroying cities, laying fields waste, and tearing up railways. Hence when the war closed, the whole section was in a miserable condition. It is no wonder that it has taken many years to build up agriculture and commerce there.

Questions

1. Describe the surface of this part of the country.
2. Name the Atlantic coast ports, and two important gulf ports.
3. Describe the climate of this section.
4. What is the principal industry, and what the most valuable crop?

5. What can you say of the cotton belt in this region?
6. Name the chief food crops.
7. Name other crops.
8. Why do men engage in the culture of tobacco?
9. Why is the great state of Texas sparsely settled?
10. Where in the Southern States is coal mined? Iron?
11. Why is there now more manufacturing in the South than formerly?
12. Mention chief manufactures.

Requirement

Upon an outline map of this section, indicate agricultural and mining products by pasting upon the map the names of products grown or mined in the different parts of this division.

Lesson XXIX

The Western States

Map Study.— What country lies north of these states? What country south? How far is it across the United States from the northern to the southern boundary? Measure the length of the longest state in the group. Compare the western coast line with the Atlantic coast line of the New England group. Find Yellowstone National Park. Locate one or more prominent mountain peaks in each of the following states: Colorado, Wyoming, Washington, Oregon, and California. Of what mountain range is each a part? Find the capital city of each state.

This group of states is crossed by the chief highland region of our country. The plateau section is about a mile high, and the mountains rise much higher, some of the peaks reaching heights where it is too cold for vegetation to grow. In the northern part of the plateau region, the winters are very long and cold; and in summer the southern part has the hottest climate in the United States.

Almost the entire highland region lies in the arid belt, and does not receive sufficient rainfall for farming. Crops are

raised by irrigating the land in the valleys of the rivers, where water can be obtained. On the plains and ridges east of the plateau proper, there is enough rainfall to yield thin grasses. Here great herds of cattle and sheep graze the year round.

The region of country devoted largely to cattle raising extends from Canada to Texas, and from central Kansas and Nebraska to the Rocky Mountains. Besides this, there are tracts of land inclosed between the mountains where the summer food is luxuriant, but where it would be impracticable to leave cattle unprotected during the winter. Here their food supply is cut off by the deep snow that covers up all vegetation for many months at a time. Snow may fall heavily upon the prairie uplands, too; but the wind sweeps over the ridges, and keeps the sweet herbage somewhat uncovered, so the stock are able to pick up a fair supply of food even in coldest weather. The cattle trade is a great source of wealth to this portion of the country. Nearly all the animals are transported to Chicago. Some are sent to New York and other large Eastern cities.

A SHEEP RANCH IN THE WEST

Although this great section is much more extensive in area than any of the other groups thus far studied, the population is very sparse. Railroads are comparatively few, those crossing the plateau being parts of the transcontinental lines built to connect the railroad systems of the East with the Pacific coast.

Mining is an important industry in the Western States. They are one of the great silver regions of the world, and produce most of the gold and copper that is mined in the United States. Much lead is obtained here from silver ore. There are also numerous coal fields. It was the discovery of gold in the West

that brought about the rapid settlement of the Pacific States, especially California. In the fall of 1848, soon after California had been ceded to the United States by Mexico, the gold fever was at its height. San Francisco was at that time a straggling village, chiefly of tents. A few wooden houses had been built, while three or four adobe structures told of Mexican occupation. At that time the richest gold-producing region of California, or perhaps of the world, was in the Sierra Nevada Mountains on the upper Sacramento, the San Joaquin, and the Klamath River. "Ho! for California!" was the cry, and from all parts of the world men flocked to dig for gold. Although three thousand miles lay between the old states and this land of gold, yet caravans were formed everywhere to go to California. The tools needed for mining were few and inexpensive. Gold was simply washed out of the gravel. This could easily be done, for gold is many times heavier than water, and would settle to the bottom of the pan in which the gravel was washed. If the gravel paid twenty-five cents a pan, a miner could make fifteen dollars a day; and often he made much more than this.

"The results of the discovery of gold in California were remarkable. There was such a rush of new settlers that in 1850 California was admitted as a state. Roads were opened up across the mountains, and other mountain states were settled. In 1859, gold was discovered in Colorado, and another great rush of emigrants followed. The rapid growth of gold and silver mining led to the development of agriculture, lumbering, fruit growing, stock raising, and irrigation of arid lands. Large cities such as Denver, Los Angeles, San Francisco, Portland, Seattle, Pueblo, Salt Lake City, Oakland, and Sacramento have grown up. The first Pacific railroad was completed in 1869, and since that time many others have crossed the plains and mountains."

In the recesses of the mountains, especially in the humid Northwest, are extensive forests for the lumbermen. The Columbia River, cutting a great natural route through the Cascades,

is noted for its beautiful scenery, and also for its salmon fisheries. The product of these fisheries is worth many millions of dollars annually, being shipped not only to the Eastern States, but to London and other European cities.

In the Northwest rise the snow-covered peaks of Mount Rainier, Mount Hood, Mount Adams, Mount Baker, and Glacier Peak, beloved of all the friends of nature who have ever seen their glorious summits. The scenery of this western country is among the most interesting in the world. The Yellowstone National Park in Wyoming is visited annually by many tourists, who love to linger in this great wonderland. Farther south is the Grand Canyon of the Colorado, a mighty chasm whose precipitous walls rise six to eight thousand feet above the bed of the river, which seems but a silver thread in its depths. With ceaseless rush its yellow waters roll on, gathered from thousands of square miles in Colorado, and from the plateaus of Utah and Arizona.

MOUNT RAINIER

The Yosemite Valley lies in the heart of the Sierra Nevada Mountains. It, too, is a national reservation. It is distinguished from all other valleys by its enormous depth and the perpendicular walls that inclose it.

Although marred by the curse that now rests upon the face of nature, these beauty spots speak to us of infinite perfection and power. Even in the deserts of the arid plateau region, where there are absolutely no springs or streams, where vegetation is wholly wanting save here and there a bunch of salt-

weed or sagebrush, or the cactus of the lonely waste, there is sublimity and infinite love written. The long, broken mountain ranges, although jagged and bare in places, are beautifully variegated with tinted rocks and shining sands; and the clear-cut peaks appear in the distance as sentinels, to remind us of our strong Protector who changes not. We should always feel His presence in the great outdoors with which we are surrounded.

Questions

1. Compare the surface of the Western States with that of the previous group studied.
2. Compare climate and industries.
3. What part of this region is devoted to cattle raising?
4. Compare the population of this group with that of other sections studied.
5. Of what does the chief mineral wealth consist?
6. Account for the rapid settlement of the Pacific coast states.
7. Locate the most extensive lumber regions of the West.
8. For what are the following noted? Columbia River, Mount Rainier, Yellowstone National Park, Grand Canyon of the Colorado, Yosemite.

Requirement

Upon an outline map of this section, indicate the highlands and lowlands, and as far as possible, secure pictures to illustrate the various industries of the section, pasting illustrations of scenery and products upon the map. (One large wall map will do for the entire school.)

Lesson XXX

Countries North of the United States

Adjoining the United States on the north is the Dominion of Canada, the largest and most important British colony in the world. Canada, together with Newfoundland and the Labrador

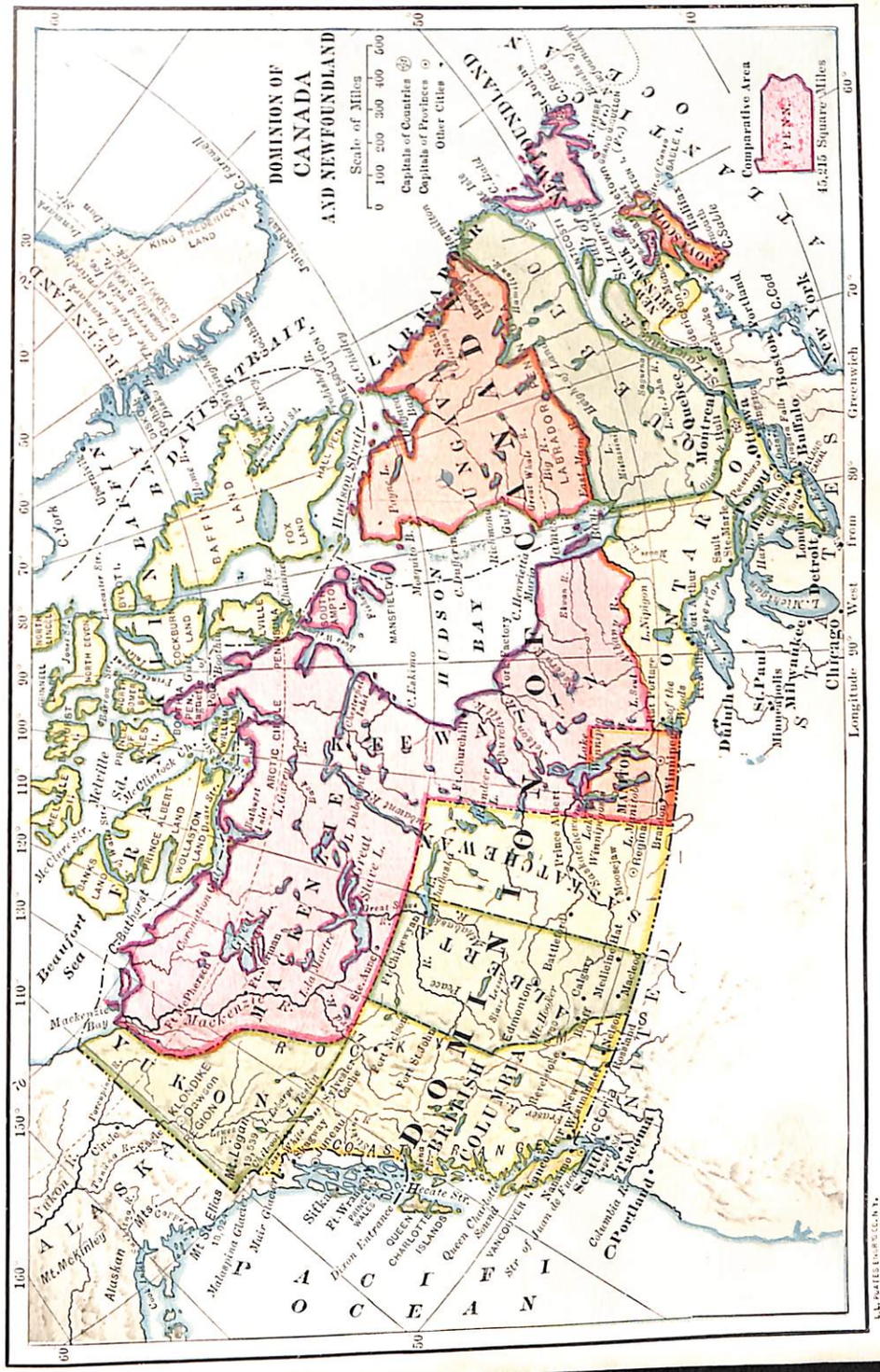
coast, which also belong to England, occupies all the continent of North America lying north of the United States, with the exception of the peninsular territory of Alaska and the island of Greenland.

Canada covers an area greater than the United States, and

THE CANADIAN ROCKIES

nearly as large as Europe. Its greatest length from east to west is 2,700 miles, and from north to south about 1,600 miles. The islands to the north probably reach to within five or six degrees of the North Pole.

We conclude at a glance that its position and extent will give to this country a great variety of climate. The northern prov-



inces of the dominion have an arctic climate,— cold and bleak. The southern provinces, although lying in the northern part of the North Temperate Zone, are variously modified. The extremes of a continental climate are felt in the heart of the Great Central Plain, which continues northward from the Central Plain of the United States.

Cold currents in the Atlantic flowing along the coast of Labrador and Newfoundland give to this region a cold, damp climate. The eastern provinces have severe winters, accompanied by great depth of snow, while the summers are short and hot. The southern part of Ontario has a more equable climate. Can you suggest a reason for this?

The section west of the Rocky Mountains has also a comparatively mild climate throughout the year. This is due to the influence of warm winds from the Pacific Ocean.

Let us notice the surface and vegetation of this broad country. The Labrador peninsula in the East is a plateau region, rising highest near the coast. It is between 1,500 and 2,000 feet above the sea. Although in part desolate and rocky, much of it is thickly forested. The whole peninsula is dotted with numerous lakes, through which rivers flow. Some of these rivers empty into the Hudson Strait, while others reach the Atlantic Ocean through the great St. Lawrence.

The waters of the St. Lawrence River basin are separated from the rivers flowing into the eastern side of Hudson Bay by a low ridge known as the Height of Land. It extends about 250 miles north of the St. Lawrence River, running parallel with the river as far as the Province of Ontario. It skirts the northern boundary of the Great Lakes, and continues west, bending southward to the headwaters of the Red River of the North. Thence it turns northwest, and, crossing North Dakota in an irregular line, reënters the Dominion of Canada, and extends westward near the international boundary line between Canada and the United States, until it reaches the Rocky Moun-

tains. This low ridge separates the waters of the Mississippi basin from the Hudson Bay and Mackenzie River basins.

The Hudson Bay region is a gently rolling country, well watered and fertile. The soil and climate of all the southern provinces, and of much of the vast interior, are well adapted to agriculture. In the fertile lake basins and in the forest clearings much wheat, oats, and other cereals are produced. The rich lands of Saskatchewan and Alberta are rapidly yielding to the plow, and extensive areas are now under cultivation, so that Canada is fast becoming one of the greatest farming regions of the world.

A STEAM PLOW AT WORK

In general the important crops are wheat, potatoes, oats, barley, peas, beans, and beets. Cattle, horses, and sheep are also raised in large numbers.

In Ontario, a great and wealthy province, the climate favors the growth of peaches, grapes, melons, and similar products. The farmers of eastern Canada devote a great deal of time to dairy farming. Cheese and butter factories are built throughout the country in the East, at very short intervals, and to these almost every farmer sends milk. Nearly all the cheese made in Canada is shipped to Great Britain, being in demand in the markets of that country. Poultry raising also receives much attention from Canadian farmers. In certain localities eggs are regularly gathered up by buyers, who drive through the country and call at each house.

Except in the stock-raising districts, the Western farmers devote their energies mainly to wheat growing. When the thrashing and marketing are over in the fall, plowing begins, and goes steadily on until stopped by the frosts of November and December. In the spring the land is seeded. Then the farmer waits for the harvest, busying himself meanwhile with his dairy cattle and the culture of potatoes and other roots. In midsummer the hay is cut, dried in the sun, and stored in barns or in stacks. If many cattle are kept, the green Indian corn stalks are cut and pressed, to be used in winter for the cows.

OATS IN ALBERTA

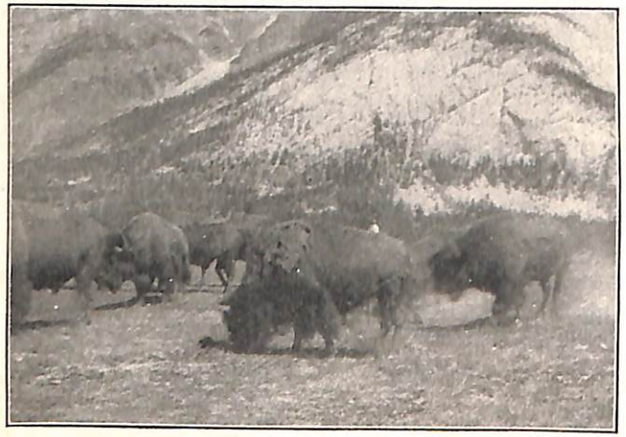
As the wheat begins to head out, the farmer casts many an anxious glance at the weather outlook, for occasionally a night frost comes at this season and damages his crop. In August the wheat ripens and the harvest begins. Just before cutting, these Western wheat fields present a lovely picture. As far as the eye can reach, the yellow grain waves and ripples in the warm summer breeze like a sea of gold.

Beginning in the Eastern Highland region, and extending in an unbroken line entirely across the continent, is a vast forest belt. It varies in width from two hundred to three hundred miles, containing a great amount of spruce, pine, hemlock, balsam, and hard woods in the eastern portion, and quantities of pine in the central, and fir in the western portion. The forest belt lies north of the farming district, and extends farther north in the western section than in the central. The firs and cedars

of the western highlands grow to immense size, hardly equaled elsewhere. Some of these reach a height of three hundred feet, and a circumference of fifty or sixty feet. These forests are extensive along the British Columbia coast, and are very valuable for lumber.

The mineral product of Canada is important. Gold, silver, copper, and coal are mined in the West. Coal is found in the East. Nickel, petroleum, iron ore, asbestos, and lead are also found. The nickel mines in Ontario produce one half of the world's output of this metal. Quarries of building stone are widely distributed.

The extreme northern portion of Canada is so cold that neither trees nor food plants grow there. The soil is frozen except for a short time in summer. The land is a *tundra*, producing only mosses, lichens, and scrubby bushes. Therefore it is not difficult to explain why the population of Canada is confined chiefly to the southern part. The only exceptions are the Eskimos and Indians. Some of the Indians are hunters and trappers. The valuable furs that they procure are sold to the Hudson Bay Company, which has trading posts in that region.



HERD OF BISONS

Among the cities of Canada is, first of all, Montreal, built on an island at the mouth of the Ottawa River. It is a center for canal, river, and railway traffic. It is also an ocean port, and has become the largest city of Canada. Originally Montreal, like Quebec, was a French post. The

quaint gabled houses and crooked streets of the lower town, also the fact that the local affairs are transacted in the French as well as in the English language, speak of its history.

Ottawa, now the capital of the dominion, was once a Hudson Bay Company station and Indian village.

Vancouver, the western terminus of a Canadian transcontinental railway, is the chief Pacific seaport and commercial city of Canada.

Victoria is another important seaport on the Pacific.

SALMON CATCH AT VICTORIA, BRITISH COLUMBIA

From Montreal, from St. John, and from Halifax, steamship lines run to European ports.

Winnipeg, the capital of Manitoba, is the largest Canadian city west of Toronto.

Regina, capital of Saskatchewan, is a stock-raising center. Calgary is a stock-raising and coal-mining center in Alberta.

Alaska is an icebound territory of the United States, bought from Russia in 1867. It consists of hilly land, drained by the Yukon, and ending in the west in a series of peninsulas pointing toward Asia. The coastal slopes receive heavy rains and snows, and great glaciers are formed, of which Muir Glacier, from Mount St. Elias, is the best known. The mountains of the south coast are the loftiest on the continent; but low, moss-covered plains fringe Bering Sea and the Arctic Ocean. The central and southern portions of the peninsula are covered with dense forests, but the broad tundras at the north are treeless.

The rich gold deposits in the Klondike and other tributaries of the Yukon have directed much attention to this section. In summer, flat-bottomed steamers sail up the Yukon almost to

its source. Along the rivers exist conditions necessary for life, and here the principal part of the population is found.

The small rivulets of the interior, and the vast swampy plains, covered with snow for seven or eight months in the year, are visited only by the trappers, when the skins of the marten, mink, and muskrat are in their prime. The inhabitants are dependent upon fish and game for food.

The large game of Alaska is the moose and the caribou, formerly abundant throughout the interior. The black and the brown bear roam over nearly all of this region; deer live on the islands in the southeast; and flocks of mountain sheep and goats graze on the highlands, both on the coast and in the interior. Of fur-bearing animals the most valuable are sea otters, fur seals, land otters, martens, beavers, minks, and ermines.

TOTEM POLE AND PARK AT SITKA, ALASKA

Greenland is a lofty island plateau, buried beneath a cap of ice of unknown thickness. It is only near the coast that the surface of the land is ever exposed. No fragment of rock or grain of sand is ever visible in the frozen interior; but the coast region of the west and south, which is washed by warm currents, is open during the short summer. Here mosses and lichens grow, also patches of grass and a few flowering plants in summer. There are a few stunted trees, but these rarely grow higher than a man's head. The principal wild animals

of the land are the musk ox, the reindeer, the arctic fox, and the polar bear. The coast waters are frequented by seals, walruses, whales, and fish. Millions of aquatic birds nest along the coast. The few people who live on this island are mostly Eskimos; but on the southwest coast are a few small trading settlements of white men from Denmark. The Danes purchase skins, oils, etc., from the Eskimos, and the island is under their rule.

Questions

1. What modifications of climate are there in Canada, and why?
2. Account for the climate of Labrador and Newfoundland.
3. Describe Labrador as to surface, drainage, and vegetation.
4. Trace the Height of Land across the continent.
5. What is the leading industry of Canada?
6. Name the other important industries.
7. What are the main agricultural products?
8. What are the most valuable mineral products?
9. Describe the forest belt of Canada.
10. What are the chief products of manufacture?
11. Locate the capital and the principal cities of Canada.

Note Book Requirement

Trace the dotted outline of the Dominion of Canada with a medium hard pencil or with ink, making an unbroken line of it. Trace also rivers and islands. Name upon your outline the Arctic Circle. Show at the end of each parallel and meridian its proper degree of latitude or longitude. Trace the boundaries, and insert the names of the various provinces. Locate the largest cities of Canada. Color to show political divisions. Upon an enlarged map outline, make a product map of this colony.

Lesson XXXI

Countries South of the United States

Map Study.— What gulf is east of Mexico? What sea is east of Central America? Find the Tropic of Cancer. Where is

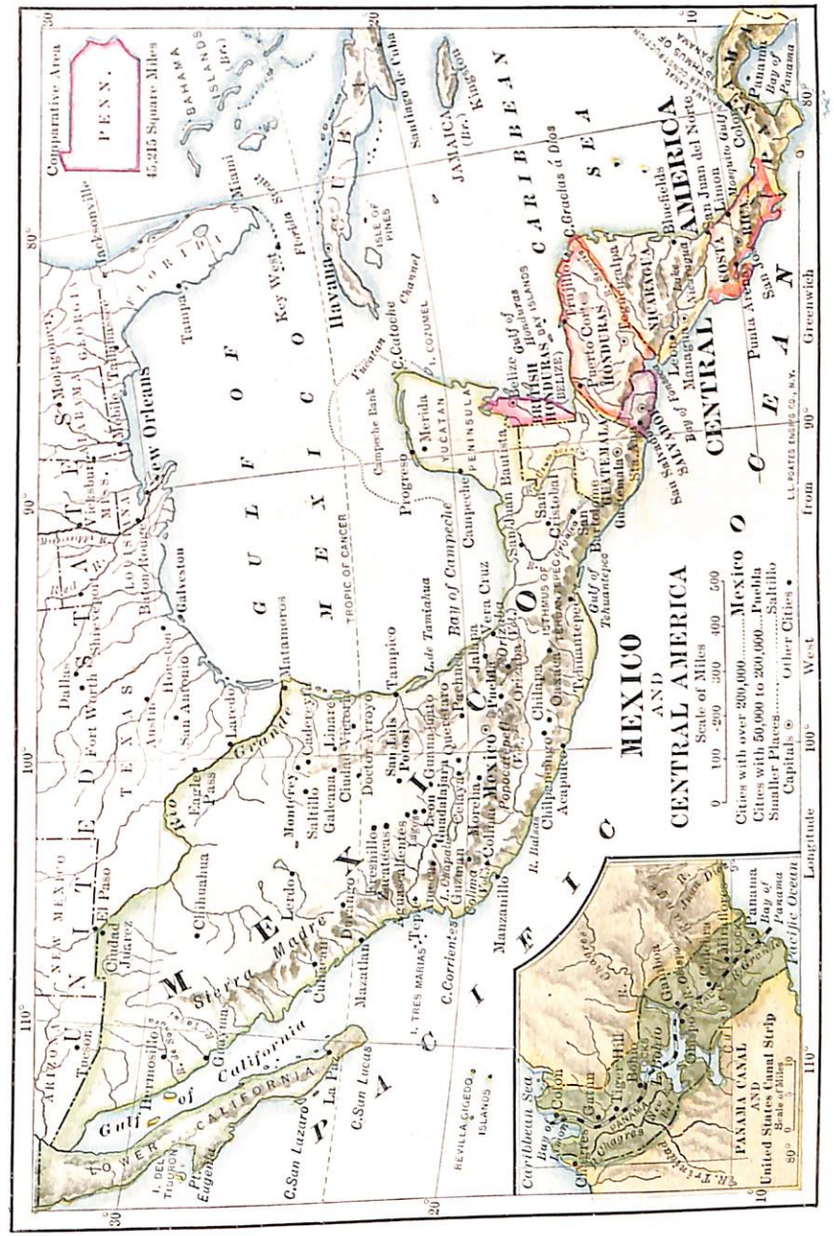
the Panama Canal? Locate a port on the Gulf of Mexico. Name the countries of Central America. Find Lake Nicaragua. What are the four largest islands of the West Indies? Locate two cities of Cuba, a city of Porto Rico, and the capital of Mexico.

Directly south of the United States lies the republic of Mexico, the most important country of southern North America. Southeast of Mexico, occupying that portion of the continent that narrows rapidly as it approaches the Isthmus of Panama, are seven smaller countries, called the Central American States. All these are republics except one. That one, Belize, is a dependency of Great Britain.

MONTEREY — SADDLE MOUNTAIN IN THE DISTANCE

Southeast of the continent is a group of islands known as the West Indies. The smaller islands of this group are but the tops of a high mountain range surrounded by the waters of the Atlantic Ocean.

All these countries except northern Mexico lie south of the Tropic of Cancer, and thus are in the Torrid Zone. Owing to this tropical position, there is little difference, in these countries, between the temperature of summer and that of winter. The seasons are known as the wet and the dry, nearly all the rains falling during the summer months. But there is a great difference in the temperature of regions at different elevations. The coasts of Mexico and Central America, being narrow lowlands, are hot, moist, and unhealthful. A little back from these lowlands, the surface slopes steeply upward, and broadens into a plateau. Here the climate is always temperate. Above this



central table-land rise mountain peaks, many of which are always snow-clad.

The plants and animals of both temperate and tropical climates are found in the countries of this section. Dense forests of mahogany, rosewood, and logwood grow in the lowlands. Rice, sugar cane, cotton, tobacco, and tropical fruits are cultivated. Coffee is grown on the lower mountain slopes, and higher up are the open forests of oak, pine, and other trees of the Temperate Zone.

The plateau of Mexico is an extension of the great plateau section of the United States. A glance at that part of Mexico adjacent to the United States shows that here the plateau has its greatest area. Like the neighboring portions of the United States, this region consists of vast desert plains. Narrow mountain ranges cross the plateau, and many cañons mark the drainage lines of the country. The mighty mountain barrier in the West, and the lesser and more broken Sierra Madre barrier of the East, gradually approach each other, and unite in southern Mexico in a group of gigantic volcanoes, which extend from the Pacific Ocean to the Gulf of Mexico. Nearly all these volcanoes are more or less active. The highest summits are Orizaba and Popocatepetl.

The surface of this region abounds in scenic surprises. The mountain grandeur is second to none for picturesque beauty. Groups of stately trees are dotted over charming level tracts in the high altitudes. From the summits of the Sierras a grand panorama is displayed to the westward. In the foreground is a vast expanse of irregularly tumbled and confused mountain ranges. Across the deep gorges and descending slopes there may be seen on the dim and distant horizon the glint of the setting sun on the waters of the Pacific. The traveler may stand upon the mountain side, with feet upon the newly fallen snow, while in the groves almost vertically below he can see the pink hue of the pomegranate, and the golden color of the orange.

These delicious semitropical fruits grow side by side with cherries, apples, peaches, and other fruits of the Temperate Zone.

In Mexico there is grown a plant that yields a kind of hemp of which cordage and hammocks are made. This hemp is an article of export. In the drier plateaus cattle, horses, and sheep are raised, and cattle and hides are exported from both Mexico and Central America. Cabinet woods and dyewoods are chief articles of export. Coffee, bananas, sugar, cacao, and rubber are other plant exports.

The mines of these countries have always been their greatest source of wealth. For several centuries the extraordinary mineral wealth of the Sierras of Mexico has been known to the world. Immense veins of silver exist in the most inaccessible places, and many a mining camp is perched among precipices where even the agile mountain mule would hardly be supposed to find a footing. From these mines of the interior large quantities of silver ore are packed to the coast on burro and mule back. The silver mines exceed in richness nearly any other mines in North America. There are also large deposits of gold, iron, copper, lead, mercury, and other minerals.

You will remember that Spain was foremost in settling the southern part of the North American continent, introducing here the Spanish language and customs. Spanish is still the language most spoken in these countries, although many years ago they became independent of Spain. Only a small portion of the present population are of pure Spanish descent. Nearly one half are of mixed Spanish and Indian blood, and more than one third are pure-blooded Indians.

English log cutters settled Belize, a strip along the west coast of the Gulf of Honduras, and as before stated, it is still a British colony. The six independent republics of Central America and the republic of Mexico have governments modeled somewhat after the republic of the United States. In Mexico there are twenty-seven states, four territories, and a federal district like the District of Columbia.

PALMS IN JAMAICA

Mexico, the capital and largest city of the republic, is located in the federal district. This is a plateau city. So also are Guadalajara and Puebla. These cities are large railway centers. The railroads of Mexico connect with those of the United States. At Puebla are manufactured the famous Mexican blankets. Vera Cruz is the chief Atlantic seaport of Mexico. It is connected by railroad with the city of Mexico. Guaymas and Acapulco are ports on the west coast.

The United States controls a belt or zone ten miles in width across the republic of Panama. A ship canal crossing the isthmus connects the Caribbean Sea with the Pacific Ocean, and makes a short water route between the east and west coasts of America. Panama is at the south end, and Colon at the north end, of the canal.

The island of Cuba contains about one half the area of the West Indies. Cuba is a republic. Haiti includes nearly one third of the area, and consists of two independent Negro republics. Porto Rico, a smaller island of the Greater Antilles, belongs to the United States. Great Britain claims about one sixth of the area of the West Indies. Jamaica, Trinidad, and the little island of Barbados are the most important of the British West Indies. Guadeloupe and Martinique are French possessions.

On all these islands the tropical climate is tempered by the trade winds. The soil is remarkably fertile and inexhaustible. Luxuriant tropical forests grow on most of the islands; and "Spanish" mahogany, and other cabinet woods and dyewoods, are valuable products for export. Tropical fruits and sugar cane are also grown for export, as are coffee and tobacco. About one fifth of the world's cane sugar crop comes from Cuba. Cattle are raised on some of these islands, and valuable iron and copper mines are located in places.

The population of nearly all these islands is dense. It is largely of Spanish or Negro descent; for the Spaniards discovered and settled the islands, and imported many Negroes from Africa to work the plantations. Only a small per cent can read or write.

The Church of Rome has held religious sway over the inhabitants of these lands ever since their discovery; yet many thousands of the people in these intensely religious countries have never so much as seen a Bible.

Questions

1. What republic lies south of the United States?
2. How many republics are there in Central America? What European possession?
3. Describe the surface of Central America.
4. Give the names of two gigantic volcanoes of southern Mexico.
5. What contrasts appear in the vegetation?
6. Name important plant products.
7. Name valuable mine products.
8. Account for the language and religion of these countries.

9. Give the origin of the British colony at Belize.
10. Describe the government of Mexico, and tell what you can of its capital.
11. What are the chief ports and railroad centers of that republic?
12. Where is the Panama Canal Zone, and by whom controlled?
13. Of what value will this canal be to the United States?
14. Name the republics and dependencies of the West Indies.
15. By what is the tropical climate of these islands tempered?
16. Account for their present population.
17. What are the principal products of the West Indies?

Note Book Requirement

Upon the skeleton map trace all coast lines and boundary lines between the political divisions of these countries. Neatly print the name of each country where it belongs upon the map. Name the Tropic of Cancer. Give to the parallels and meridians their proper degrees of latitude and longitude. Indicate the mountains and volcanoes of Mexico. Show the Panama Canal. Locate the largest cities of these countries. Color the map to show political divisions.

Lesson XXXII

Map Study on South America

Location.— In what direction is South America from North America? What is its latitude? What is its longitude? What part of South America is in the same longitude as Florida? In what zones does it lie? What waters surround it?

Shape and Coast Features.— Compare the general shape of South America with that of North America. Is the coast of South America more or less indented than that of North America? Name the capes at the four extremities. Near what part of the coast are there many islands? What large island is south of South America? What strait separates it from the mainland?

Surface.— Where is the great highland region of South America? Compare it with that of North America in length;

in width; in height; in nearness to the coast; in general direction. What plateaus are in the eastern part of South America? Compare these eastern plateaus with the eastern highlands of North America in size and position. How does the great lowland of South America compare with that of North America in position? In size?

Drainage.— Contrast the various river systems of the two Americas. Compare the lakes of South America with those of North America in number, size, and position. Name four rivers that are important to commerce.

Note Book Requirement

Trace the coast line of South America. Name the sea and oceans that bound it. Name the Equator and the Tropic of Capricorn. Indicate the Andes Mountains. Trace the boundaries of Brazil, and insert its name on the map. Trace the Amazon River and its tributaries, naming four from the south and one from the north. Show the mountains of Brazil. Trace and name the San Francisco River. Trace the various rivers whose waters reach the ocean through the Plata, and name the largest. Trace the boundaries of Argentina, and insert its name on the map. Trace the boundaries and insert the names of the countries occupying the Andes region. Indicate the boundaries and names of the three Guianas and of Venezuela. What two countries of South America have no seacoast? Trace their boundaries and insert the names. With colors indicate the political divisions of this continent.

Lesson XXXIII

The People and Countries of South America

He is our peace, who hath made both one. Eph. 2: 14.

South America is the home of about forty millions of people. Some are scattered over extensive plains, and some are hidden

away among the valleys of lofty mountain ranges; but the bulk of the population is grouped in settlements along the coast.

It was upon his third voyage to the New World that Columbus discovered this interesting continent. Approaching its northern shore, the bold navigator saw before him the wide mouth of a mighty river. It was the Orinoco, which, gushing forth like a shoreless sea, flooded the ocean with fresh water. Columbus was convinced that a continent, and not an island, lay before him. "Such an enormous body of fresh water could only be collected from a river having a long course," he said. What do you think Columbus would have thought had he approached the continent at the mouth of the great Amazon, which drains an area nearly the size of Europe, and is the largest body of fresh water in the world? Or had he touched the continent at the mouth of the Plata River, which is one hundred and fifty miles in width,— the widest river in the world,— how would he have been impressed?

AN INCA INDIAN

South America was at that time inhabited by a native people of the same race as found upon the islands and continent adjacent. There were probably more Indians in South America than in North America at the time of discovery; and the *Incas,* a very intelligent tribe, had reached a more advanced degree of civilization than any other South American natives. The home of this people was in the interior. The land drained by Lake Titicaca, on the plateau of Bolivia, was the

cradle of the Inca civilization. Here they had built roads and houses of stone. They knew how to work in gold and silver, of which they made themselves beautiful ornaments and utensils. They made bronze; they cultivated corn, potatoes, and cotton; they used the llama as a beast of burden, and the wool of the alpaca they wove into cloth.

The Spaniards who followed Columbus to the north coast soon learned of the gold-working Incas. They made their way into the Andes highland, conquered the Incas, and occupied their country. The city of Lima was founded by Spaniards in 1535, under the leadership of the cruel Pizarro. In a museum of that city there is a large painting representing the death of Atahualpa, the last Inca king. The treachery that led to that event, and the cruelty that the Indians have since suffered, would make a long, dark story. The Spanish also made settlements in the Plata Valley.

Meanwhile explorers from Portugal conquered much of the east coast, which came to be called *Brazil*. To these agricultural settlements the Portuguese brought thousands of slaves from Africa to work their plantations. Thus most of the eastern and central part of the continent was claimed and settled by the Portuguese; while the Andes region, and the lower part of the Plata basin, were settled by the Spaniards. The Portuguese and the Spaniards enslaved the Indians, and forced them to work in the mines and on the plantations. On the northeast coast a few settlements were made by the English, the Dutch, and the French.

Some of the white settlers married Indian women, and in the East many Indians and Negroes intermarried, so that now a large portion of the people of South America are of a mixed race.

Like the colonies of Mexico and Central America, the Spanish colonies of South America after a time became independent republics. The Spanish language continues to be spoken in these countries, however; and in Brazil, which is now also a republic, the Portuguese language is still spoken. The governments of

all these republics are somewhat like that of the United States. In all of them there have been frequent civil wars, and many difficulties between countries about the question of boundaries, some of which are not yet definitely settled. Partly because of this, the industrial progress has been slow.

However, slavery has been abolished, and settlers are now coming in thousands from Europe. Especially is the southeastern region becoming rapidly settled. In this part of the continent an extensive railroad system is building, and it is now possible to make a transcontinental journey from the Atlantic to the Pacific in about a day and a half. One may breakfast in Buenos Aires, the New York of South America, and rest the second night in Valparaiso, the San Francisco of the southern continent.

Buenos Aires, the capital of the Argentine Republic, and the largest city of South America, is the largest Spanish-speaking city in the world. The commerce of a young and productive land, that yields almost without the asking, has made this growing American metropolis. Argentina exports much wheat. It occupies a prominent place among the nations in the raising of cattle, sheep, and horses.

Leaving the capital of this prosperous republic, the trip by rail soon carries the traveler out of sight of the city. The *pampas* stretches like a calm, unruffled sea in all directions. Mile after mile of rich, level country intervenes between the small towns that greet the sight and then disappear. Browsing cattle are almost never out of sight. Herds of wild ostriches, frightened by the locomotive, scamper away. Endless ranks of telegraph poles and barbed wire fences parallel the road of steel. For nearly six hundred miles the train follows this nearly curveless, nearly gradeless railway line, and then connects with the narrow gauge trans-Andean line that carries the traveler up into the wild heart of the Andes.

The scenery here is on a scale so vast that even Aconcagua, the king of the Andes, and the highest crest in the Western Hemisphere, seems dwarfed by the tremendous setting.

At an altitude of 13,000 feet above the sea, marking the western limits of the wide Argentine Republic, and the eastern limits of the narrower republic of Chile, stands a huge bronze statue known as the "Christ of the Andes." This monument was set here to commemorate the peaceful settlement of a boundary difficulty in which both nations were victors. The two republics, personified as goddesses of liberty, are represented upon the pedestal of the monument as standing in the fond embrace of friendship, each pointing proudly toward the land she represents, as if to say, "There lies your sister land of Chile," or, "Yonder stretch the boundless acres of Chile's sister, Argentina!" Above these figures are the Latin words which read, "He is our peace, who hath made both one."

Passing through the trans-Andean tunnel, the descent by railway begins on the Chilean side. The locomotive slowly and cautiously lowers the little train along the fearful grades, dropping some seven thousand feet in about thirty miles. The wilderness of rock is left behind, trees reappear, and the trans-Andean railway ends at Los Andes, where the broad gauge Chilean line begins.

NITRATE FIELDS OF CHILE

Santiago, the capital of Chile, is the largest city on the Pacific slope in South America. Situated at the base of the Andes, it commands a view of the grandest mountain panorama in the world. A hundred miles of Andes, peak after peak, ranging fifteen to twenty-three thousand feet in height, are seen from this city.

In Brazil, and the other countries occupying the northern part of the South American continent, there are natural bounties of every description. The elevation of the surface of this continent combines with the trade winds to produce a climate much cooler and more healthful than that of the corresponding latitudes of Africa and southern Asia. These wonderful trade winds, which blow upon the two Atlantic sides of the great triangle, come laden with moisture. They bear this burden of vapor over the land, distilling refreshing water upon the vast forests and the lesser mountains, until, finally caught by the lofty Andes, it is wholly condensed by the cool atmosphere, and descends in copious rains, which nourish the sources of the mightiest rivers of the world.

GRAIN READY FOR SHIPMENT IN ARGENTINA

The whole northern part of Brazil lies in the Amazon Valley, much of which is covered with dense and often swampy forests. In this region there are but few inhabitants, and these are chiefly Indians. Many of them are employed in the rubber industry. They collect the sap from the rubber trees, and harden it into crude rubber. It is then sent down the river to be shipped to Europe and the United States. The great agricultural region of Brazil is a coast strip along the east and the southeast. Fully six sevenths of the population of the country live in this region. Rio de Janeiro, the largest city of Brazil, and the second city of South America in size, has one of the few fine harbors of that grand division.

The foremost industries in South America are herding, agriculture, and mining. The chief pasture lands are the *pampas* in the South and the *llanos* in the North. The valleys of the Plata River system, the southeastern part of the Brazilian plateau, and the river valleys along the northern coast of the continent, are the principal agricultural regions.

The products of the Torrid Belt in South America are coffee, sugar cane, cotton, cacao, cassava, tobacco, and rubber. In the Temperate Zone wheat, corn, barley, and flaxseed are the leading crops. Gold, silver, and copper are mined in the Andes. Another valuable mineral product, nitrate of soda, useful as a fertilizer and in making gunpowder, is a product of the Pacific slope.

Questions

1. How does the population of South America compare with that of North America?
2. Where do we find the bulk of population in South America?
3. By whom was South America discovered? When? Where? What republic bears the name of the discoverer?
4. Find out all you can about the Incas.
5. Make a list of the nine Spanish republics and give the capital of each.
6. What settlements were made by the English? Dutch? French?
7. What Portuguese republic is there in South America?
8. Mention hindrances to the industrial progress of these countries.
9. Describe a trip by rail across the southern part of the continent.
10. Describe two large cities on the Atlantic and one on the Pacific.
11. Give reasons for the copious rains of the Amazon Valley, and lack of rain in the Pacific coast desert region.
12. Make a list of the chief vegetable and mineral products of this continent.

Requirement

Make a product map of South America, drawing your own outline.

Lesson XXXIV

Map Study on Europe

Location.— Bound Europe. Notice the latitude and longitude of this continent. What point on the American mainland is about the same latitude as the most northern point of Europe? What point on the eastern coast of America is about the same latitude as the most southern point of the European mainland?

HARBOR OF HAMMERFEST

Shape and Coast Features.— Compare Europe in shape and size with the continents previously studied. What group of large islands is near the west coast? By what is Great Britain separated from the mainland? Beginning with the White Sea, name all the waters that wash the shores of the continent. What lonely island lies northwest of the British Isles? Name the four largest islands of the Mediterranean Sea. What is the most northern point of the European mainland? Name two capes on the coast of Spain. What strait connects the Mediterranean and the ocean? How wide is this strait?

Surface.— From the Ural Mountains, trace the divide between the northern and the southern slope of Europe. Where are the Alps, the Carpathian, and the Caucasus Mountains? What mountains separate France from Spain? Name the mountain range in the Scandinavian peninsula. What range ex-

tends through Italy? What two mountain systems are on the borders of European Russia? Through what part of Europe does the great Eurasian highland extend? The great Eurasian lowland?

Drainage.— Into what two arms of the sea is the northern slope drained? Name two rivers that flow into the Baltic Sea; two that flow into the North Sea; one that flows into the Bay of Biscay. Into what seas is the southern slope drained? Name the two largest rivers of the Caspian basin; the three largest of the Black Sea basin. What river flows into the Adriatic Sea? What two rivers flow into the western part of the Mediterranean Sea? Name the river that flows into the Sea of Azov. Compare the lakes of this continent with those of the North American continent as to size and number.

GENERAL VIEW OF FRANKFORT ON THE MAIN

Note Book Requirement

Trace the coast line of Europe. Indicate at the ends of each parallel and meridian its proper degree of latitude or longitude. Name the two continents south and east of Europe. Trace and name three large islands west and northwest of Europe. Name the chief ocean arms that project into the continent. Trace all the rivers shown. Designate the principal mountain ranges. Trace the boundaries and insert the names of all the countries. Locate the capital of each country. Locate Poland, Finland, Lapland. Name a port on the Black Sea, one on the Gulf of Riga, and one on the Gulf of Finland. Name a port in the extreme north of Russia, and one on the Caspian Sea. Color the map to show the political divisions of the continent.

INTERLAKEN AND JUNGFRAU

Lesson XXXV

The People and Countries of Europe

Europe is the mother continent of the New World. Although in area only a little larger than the United States, it contains several times as many inhabitants. Europe is the home of about twenty great civilized nations.

The waters surrounding the peninsulas of Europe, and the highlands of the mainland, form barriers between the nations. In times past, before the days of travel by railroads and steamships, each group of people thus separated from others learned to govern themselves, and each formed a language of their own. In this way the various languages of southern Europe, such as

Spanish, Italian, French, and Portuguese, were developed from the Latin root. The languages of the Teutonic people of northwest and central Europe came to be different also, as the German, the Danish, the Norwegian, and the Swedish languages.

The countries of Europe, being so much older than those of the New World, and more progressive than the other countries of the Old World, may be very properly called the teacher of all nations. Certain countries of Europe have taken the lead in the discovery and settlement of unknown and distant lands. They have carried to these new countries their knowledge of agriculture, of mining, of manufactures and commerce. They have carried to them a knowledge of literature and history and music and art. The whole world looks to Europe for leadership in these things, and people from all countries go there to study in the great schools and libraries.

In order of importance and influence, the six countries of Europe that are now especially prominent are, England, Germany, France, Austria-Hungary, Russia, and Italy. These are known as the six great powers of Europe.

England, the ruling power in the British Isles, occupies the western approach to the continent. These islands support a dense population. Their vast deposits of coal, iron, tin, and other minerals, their productive soil, their great extent of seacoast, and the number of good harbors, are among their principal sources of wealth and power. The English-speaking people are the most enterprising the world has ever seen. The British nation surpasses every other in manufacture, commerce, and shipping.

In that country, as in all others in Europe, the traveler can visit many places of historic interest,— places hallowed by years gone by. London, Liverpool, and Glasgow are the chief seaports of the British Isles. The British Empire is a limited monarchy.

Until the year 1871, the country marked *German Empire* on the map was divided among a large number of small independent governments. In that year they all united to form a single

empire. The government is a monarchy. The ruler is called the *kaiser*.

The Rhine, the great river of Germany, has cut through the plateau a narrow, picturesque valley, whose steep slopes are terraced for vineyards, and crowned with the ruins of old castles. In its lower course, the river has a broad flood plain, which is covered with meadows and fertile fields.

About nine tenths of the land in Germany is productive. The southern highlands are covered with forests. The river valleys are noted for their vineyards. Rye is the grain most grown, and the sandy soil yields an abundance of potatoes and sugar beets. Germany is also a great mining country.

Woolens, cottons, silks, and linens are leading manufactures; also all kinds of hardware, and porcelain and wooden articles.

The commerce of this country is important, being facilitated by navigable rivers connected by canals, and by a complete network of railways.

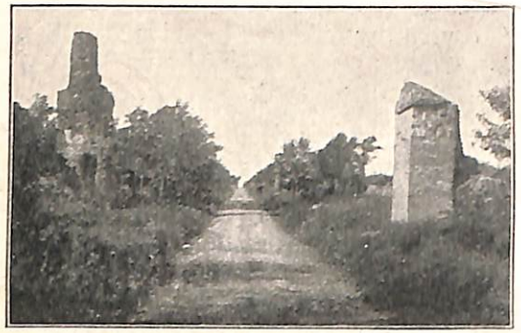
ENTRANCE TO PORT OF NICE

Berlin is the capital city, and the largest city in the empire. Because of its museums, libraries, and institutions of learning, it has been called the "City of Intelligence."

France is a republic. It is one of the wealthiest of the European nations, and is an important agricultural country. On the prairie lands of northern France about one half as much wheat is produced as in the United States. Crops of sugar beets, potatoes, and other vegetables are cultivated, and many cattle and sheep are raised. The grape is a leading product of central and southern France, and the rearing of the silkworm is an important industry.

Next to the British, the French are the foremost cloth makers of Europe, and they lead in the manufacture of silks and velvets. France ranks third among the countries of Europe in commerce. Paris is the third city in the world in population, and is said to surpass all others in magnificence and beauty.

A railroad tunnel through the Alps connects France with the kingdom of Italy. The climate of Italy is exceptionally warm for its latitude. Italy is one of the greatest wine and silk producing countries in the world.



VIA APPIA

More than one fourth of the people of Italy are engaged in manufacturing. The making of macaroni is one of its industries, as is also the manufacture of ornamental articles of glass, stone, metal, and other material. Raw silk, wine, olive oil, and sulphur are exported.

The capital of Italy is Rome. Because of its ancient greatness, it is the most famous of Italian cities. It is the seat of the Catholic Church, and in it is the palace of the pope — the Vatican. In this city the apostle Paul was imprisoned for his faith, and from here papal persecution was carried on during the period of European history known as the "Dark Ages," when the true church had to be nourished "in the wilderness." Into the Waldensian valleys of the Alps Mountains the Protestant Italians fled for refuge. Here the true faith was preserved by a liberty-loving people, and the Waldensian Christians became missionaries to all Europe and the world. They carried written portions of the Scriptures with them as they went from city to city in the guise of merchants.

Mountain ranges traverse Austria-Hungary, and nearly inclose the low, fertile plains of Hungary. The Danube enters these

prairies through a gap in the mountains, and it leaves them through a similar gap in the Southeast.

Agriculture is the chief occupation. Grain, flax, hemp, and grapes are raised, and meat and dairy products also are exported. The raising of the silkworm is carried on in the warmer parts of the country. Lumbering and mining are also among the leading industries. Vienna, the capital of Austria, is a brilliant and beautiful city. Budapest, the capital of Hungary, is an important grain market and milling center. Probably no other nation has put so much effort on the development of its capital as has Hungary.

European Russia is a low, flat country. In the North the winters are long and very cold; and even in the South the winters are severe, but the summers are hot. The rainfall, though not abundant, is sufficient for crops.

Russia is not a free country like America. The government is one of restriction. A passport must be secured and carried from place to place in order to travel in that country; and this passport must be signed by the proper official before the traveler can leave the country. The mass of the Russian people are uneducated, their condition being little better than that of serfs.

The houses, which are low, one-story structures, are scattered about in the towns, with little apparent attempt to place them in orderly arrangement. Many are covered with very heavily thatched roofs. The windows are few, as are also the smoke flues. Some of the houses have no chimney whatever, the smoke from large stoves or ovens, contributing to the warmth of the occupants.

Scattered throughout the country, near the villages, are many old-fashioned windmills. These furnish to millions of the country people the only means for grinding their grain. Naturally the product of such mills is not of the finest quality, but the peasants are accustomed to very coarse bread.

There is one striking feature to be seen in every village,— the orthodox church. A very wretched looking village is almost

sure to have a beautiful church. The painted and gilded domes and pinnacles can be seen by travelers for many miles. Another feature just as striking as the ever present church is the never present school. None of the villages have schools.

Russia is governed by an emperor, called the *czar*. St. Petersburg is the capital city.

Belgium and Holland are two independent kingdoms lying on the coast between France and Germany. Every one who wishes to see the highest rewards paid for industry, thrift, and economy, should visit this part of Europe. Much of Holland lies below the level of the sea. It was several centuries ago that the Hollanders began to build dikes, and to drive back the sea by artificial drainage. By means of windmills, the air is made to pay toll, and by its power the seeping water is pumped from where it is not wanted into channels where it is permitted to run.

Much like Holland, the greater part of Belgium is a low, fertile plain. Agriculture is here the principal occupation. Brussels, the capital of Belgium, is an important manufacturing city.

Amsterdam is the capital of Holland. The city is built on piles, and the canals which run through many of the streets divide the city into about ninety islands. Holland carries on much commerce. The exports include dairy products, vegetables, flower bulbs, flax, linen and cotton goods, and products of the Dutch colonies in the East and West Indies and in South America.

Denmark is a hillier country than the Netherlands. Parts of it are covered with beech forests. Farming and dairying are the chief industries. The country is celebrated for its butter, which, with meat, forms its chief export. The Faroe Islands, north of the British Isles, Iceland, Greenland, and three of the West Indies are Danish possessions.

The kingdoms of Sweden and Norway occupy the Scandinavian peninsula. The Norwegians, the Swedes, and the Danes are closely related, and are called Scandinavians. Norway is a

mountainous plateau whose west coast is much indented with deep, narrow *fiords*. A large part of Sweden is lowland, yet it has mountains so high as to be covered with eternal snows. There are extensive forests of spruce and hemlock, and a great number of beautiful lakes. It is said that one tenth of the entire area is covered with lakes. The larger of these have been connected by canals, so that small ships can cross the country. These numerous bodies of water serve to modify the climate, which, from the position of the country, would otherwise be very severe.

Fishing and lumbering are the chief industries of Norway. Agriculture, dairying, lumbering, and the mining of iron ore are the industries of Sweden. Stockholm, one of the most beautiful cities of Europe, is the capital of Sweden, and Christiania is the capital of Norway.

MOUNT BLANC — ICE PINNACLES IN SWITZERLAND

Switzerland is a republic. It is much visited by tourists in summer, because of its high, snow-clad mountains, its lakes and beautiful waterfalls. It is an active manufacturing region. The German language and customs prevail in the North, French in the West, and Italian in the South. Berne is the capital.

Spain and Portugal are two kingdoms occupying the Spanish peninsula. The foreign commerce is not large. Spain once had large colonial possessions, which have now shrunk to a strip on the northwest coast of Africa, the volcanic Canary Islands off that coast, and some smaller West African possessions. Grapes, wine, and raisins are exported from Spain, and wine from Portugal. Madrid is the capital of Spain, and Lisbon is the capital of Portugal.

Greece is a peninsula country famous in history. Since the early days of its greatness, it has for long periods been under the rule of Teutonic barbarians, and then of Turks. Under these foreign peoples, it has been sadly reduced in both wealth and culture. Athens, the capital, contains relics of former splendor, among them the ruins of the Parthenon, a famous ancient temple.

VIEW OF ACROPOLIS, ATHENS

European Turkey has been gradually dwindling. The kingdom of Roumania formerly belonged to Turkey, but is now independent. Bulgaria, which was formerly tributary to Turkey, is now independent. The kingdoms of Servia and Montenegro also used to be a part of the Turkish Empire. Owing largely to misrule, neither Turkey nor the Balkan countries just named have developed as they might otherwise have done. The Turkish government has been the worst in Europe. Until recently the ruler, called the *sultan,* has been an absolute despot. He has governed the people so badly that they have been kept very poor and ignorant. Constantinople, the largest city of southern Europe, is the capital of the Turkish Empire.

Questions

1. Why is Europe spoken of as the northern continent?
2. Make a list of the countries of Europe, placing the six great powers at the head of the list. Opposite each country write the name of its capital.
3. Account for the numerous and distinct languages of the nations of Europe. Give examples.
4. Why is Europe called the teacher of the continents?

5. For what are the British Isles noted?
6. Name important products and manufactures of each of the six great powers of Europe.
7. Who were the Waldenses? For what are the Hollanders famous?
8. Describe a trip through Russia.
9. Make a list of products and manufactures of all the countries of Europe.
10. What two countries in Europe are republics?
11. How many and what countries in Europe have no seacoast?
12. What countries of Europe are ruled by kings? Which is ruled by a sultan? Which by a ruler called the *czar?* Which by the kaiser?
13. Name countries in Europe that are to-day less famous than anciently. Name a country that is gradually losing its territory, and that its neighbors are striving to drive out of Europe.

Lesson XXXVI

Map Study on Central Europe

France.— What channel and strait lie north of France? What gulf projects from the Mediterranean into the south of France? Name an island in the Mediterranean belonging to France. In what part of France are vines and mulberry trees cultivated extensively? What other crops are raised? Name and locate the capital of France. What port is there at the mouth of the Seine? What port in southern France?

Germany.— Name four rivers that cross Germany and empty into the Baltic or the North Sea. For what is the Rhine noted? What part of the German Empire is in the coast plain? Where is the mining section of Germany? Where are the forest regions? What part of Germany is devoted to agriculture? What are the chief agricultural products? From what is sugar manufactured in this country? Name other manufactures. What articles necessary to the manufacture of hardware and porcelain abound in

Germany? How is the domestic commerce of this country facilitated? Name and locate the capital. For what is it famed? Locate Hamburg.

Italy.— Locate the Po and the Tiber River. Where are the Apennine Mountains? Name two islands in the Mediterranean Sea that belong to Italy. Locate Rome, Genoa, and Venice. Tell something of interest regarding each. Name the important industries of this country. Name some of its exports. For what is Rome famous? Name two volcanoes, one in Italy and one in Sicily. Locate Pompeii. Wherein is it remarkable?

Austria-Hungary.— What mountains partly surround the fertile plains of Hungary? What river flows through these plains? What crops are raised in this country? Name the three leading industries. What are the exports? Locate the capital of Austria. Of Hungary. State some interesting fact regarding each

Note Book Requirement

Upon the outline map of central Europe, trace the coast line of Europe as far as given. Trace the boundaries, and insert the names of the countries of Europe shown on this map. Name the islands. Locate the capital of each country of central Europe. Locate famous peaks of the Alps Mountains. Indicate the mountains of this part of the continent. Color the countries to show political divisions.

Lesson XXXVII

Map Study on Asia

Physical Features.— What physical features are often considered boundaries separating Eurasia into the two grand divisions of Europe and Asia? Compare Asia with other grand divisions in size.

Give the names of the oceans and ocean arms that border the coasts of Asia. Locate five peninsulas of Asia, and state

A BATHING GHAT IN INDIA

what waters they separate. Name two island groups off the east coast.

Name the great rivers of the Arctic slope; four of the Indian Ocean slope; four of the Pacific slope. Describe the interior region of Asia. Notice the chief slopes of the continent. Locate the principal mountain ranges and the highest mountain peaks.

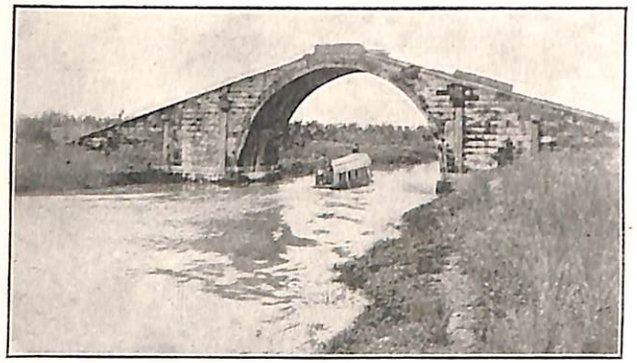
Political Study.— Describe the boundaries of Asiatic Russia. Find the distance in miles from the Ural Mountains to the Sea of Okhotsk. Describe the surface of Siberia. Why are there no seaports on the northern coast?

What waters form part of the boundaries of Asiatic Turkey? What countries border on it? By what is it separated from

European Turkey? Where are its mountains? Name its two chief rivers.

What waters partly surround Persia? What countries border on it? What two countries lie between Persia and India?

Bound India. What two rivers of India rise in the Himalayas? What division of British India lies east of the Bay of Bengal? What narrow peninsula extends still farther south? What native kingdom lies between the British and the French possessions in Indo-China? What country occupies the southern part of the Malay peninsula?



A BRIDGE OVER A CANAL IN CHINA

What waters border on China? What plateau forms the western part of China? What are its two great rivers? What waters nearly surround Korea?

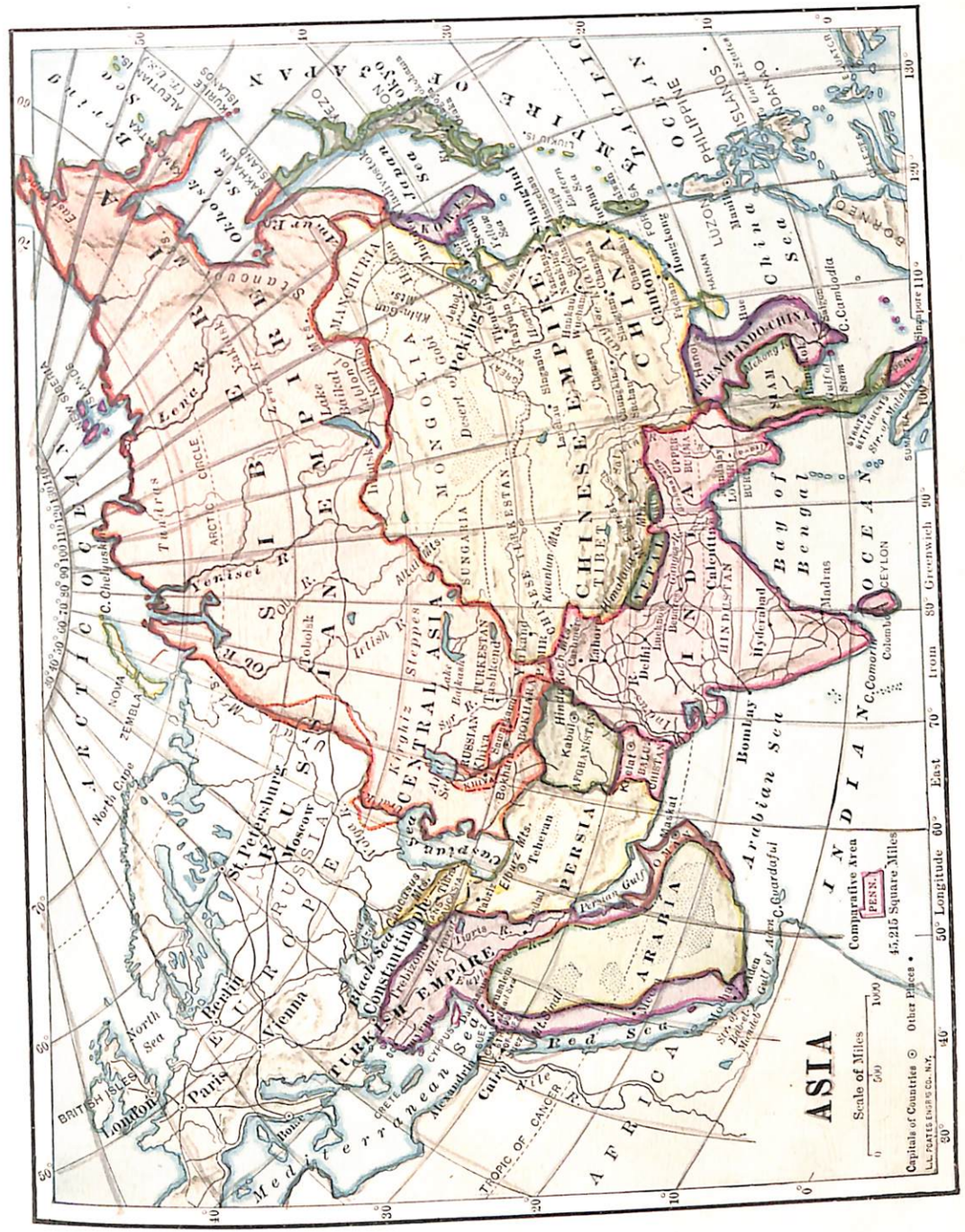
Compare the extent of the Japanese islands in latitude with that of the eastern coast of the United States. Name the largest island.

In what direction from Japan are the Philippine Islands? What is the capital?

Name the largest islands of the East India group. Name the seas and straits between the islands.

Note Book Requirement

Trace the coast line of Asia upon the skeleton map. Trace the rivers and the islands. Insert the names of the chief rivers and island groups. Name the principal ocean arms. Insert the political boundaries, and name the countries. Locate the largest cities. Color to indicate the political divisions.


ASIA
Scale of Miles
Capitals of Countries ⊙ Other Places •
Comparative Area
PERSIA
45,215 Square Miles
INDIA
Bay of Bengal
Arabian Sea
Red Sea
Mediterranean Sea
Black Sea
Caspian Sea
North Sea
ARCTIC OCEAN
PACIFIC OCEAN
China Sea
Philippine Sea
Sea of Japan
Yellow Sea
Java Sea
Celebes Sea
Timor Sea
Coral Sea
Tasman Sea
Banda Sea
Arafura Sea
Gulf of Carpentaria
Great Australian Bight
Great Sandy Desert
Great Victoria Desert
Great Desert
Lake Eyre
Lake Torrens
Lake Amadeus
Lake Gairdner
Lake Frome
Lake Macdonnell
Lake Callabonna
Lake Blanche
Lake Hope
Lake Kopperamanna
Lake Gregory
Lake Disappointment
Lake Mackay
Lake Nash
Lake Nash
Lake Nash

Lesson XXXVIII

The People and Countries of Asia

Asia contains one third of the land surface and one half of the people of our globe. This was the first continent peopled, and therefore its civilization is the oldest in the world. Just as Europe may be called the mother of the peoples in the New World, so Asia is the mother of the nations of Europe and of all continents.

The population of this continent, although vast, is very unevenly distributed. The mass of the people live in the monsoon lands from India to Japan. The term "monsoon" is given to the winds of the Indian Ocean, which, in summer, come laden with moisture from the southeast. Heat and moisture at the same season produce rapid and abundant growth of crops in southern and eastern Asia. The greatest density of population is found in the fertile areas of the great river basins.

AN OLD ARCH INSIDE THE CITY OF NANKING

In marked contrast with the fertility of this section are the desert lands of southeastern Asia, and the mountainous region of central Asia, which is cold and dry. Outside of the monsoon lands, much of the population is nomadic,— pastoral on the steppes, or plateaus, and hunting and semipastoral on the tundra.

GOING TO MARKET IN PALESTINE

The northern shore lands are an arctic waste,— in winter a terrible desolation, and never at any season suitable for agriculture.

Black, white, and yellow men live in Asia; but the yellow are most numerous. Black men are found in the hills of southern India, in Indo-China, and in the southern islands. The yellow men live in the East, North, and center. The white men occupy the Northwest, and are advancing eastward through Siberia along the railway.

At all periods of history, people have moved back and forth between Asia and Europe across the steppes of the western mountains. At the present time the movement is from Europe to Asia. Russia has gradually moved across the steppes to the extreme East, and has grown at the expense of China.

A part of Arabia, and other portions of southwestern Asia, are ruled by the sultan of Turkey. India, Ceylon, and the tip of the Malay peninsula belong to Great Britain, which also holds outposts in China. France controls much of the Indo-Chinese peninsula, and also possesses a Chinese port. The southeastern islands are under the control of Britain, the Netherlands, the United States, and Portugal.

For long ages, most of the governments of Asia have been absolute monarchies, as were the countries of Europe over a thousand years ago. This accounts for the backward civilization of the nations. Among the native peoples, the value of machinery is scarcely yet recognized, and nearly all work is done by human labor, or by that of domestic animals. The mass of the people are wretchedly poor and uneducated.

Facilities for transporting produce from one place to another are meager. The few railroads are mostly in the hands of Europeans who have settled in Asia, and it is said that the entire foreign commerce of the continent is less than that of the United States.

CHINESE EVANGELIST READY FOR THE ROAD

Worse than all else is the condition of these people religiously. Brahmanism, Mohammedanism, and Buddhism are the prevailing religions. Millions are here living in gross heathen darkness, and perishing without even a chance to hear the story of a Saviour's wonderful love.

They know nothing of His near return to end the night of sin and misery and bring deliverance to all who are prepared to meet Him.

But the natives of Asia are awakening. An Arabian ruler is said to have expressed himself in these words to the American consul at Aden: "The world is changing, and we must change, too, or we shall not survive. My people are poor. They have no roads. They do not know things in the world. When they do know, they will change. If some one would come and teach them, they would be glad. It is no use for them to buy seeds, for they know not how to grow crops. It is no use to buy your agricultural machinery, for they know not how to use it. If some man would come to teach us, we would make him our brother. It is my ambition to have one man come to teach English and the new sciences to my children, and another to teach my people how to make their crops grow."

TRAVELING IN THE MOUNTAINS OF INDIA

For centuries China, with 400,000,000 people, has been bound down by superstition and ignorance. Although a remarkable people, and a nation that has done many wonders in the past, they have for centuries made very little progress. China has, until recently, ignored the arts and inventions of other nations. Until a few years ago, there were no railroads in China. Great numbers of the common people knew little outside of their own clan or village. "If some one would come and teach them, they would be glad." They need a "brother" helper.

But they are throwing off the sleep of ages. For a generation many of the ambitious young men have been receiving their education in the schools of other nations. These are now becoming the leaders in China; and as knowledge increases, the Chinese are beginning to "run to and fro." As minds are broadened by contact with Western civilization, they are making more and more use of opportunities for travel. The vast waterways are now crowded with craft, railroads are constructed, and even the interior of the country is awakening.

China now purposes that her sons and daughters shall have educational privileges. At Peking a university has been created by the government, and in many places primary schools have been started. Missions are doing much toward the uplift of the nation. Sixty thousand pupils are receiving instruction in mission schools.

VIEW OF A CHINESE STREET

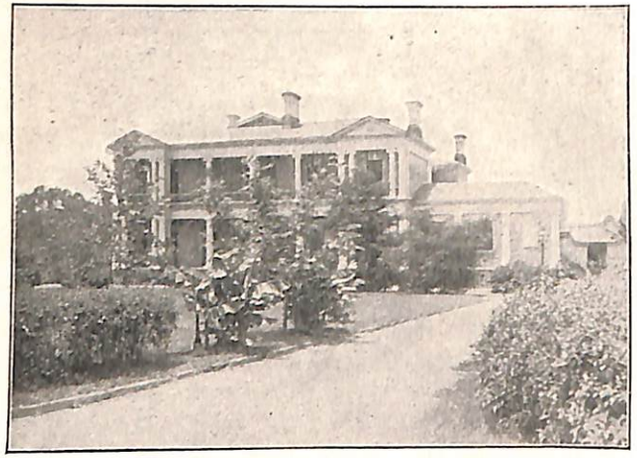
The agricultural wealth of China may be seen by the fact that it sustains a population more than four times that of the United States. It also possesses wealth in minerals and coal, vast and undeveloped. Her capacity for manufacturing, when her raw material, vast natural resources, and labor are utilized, will be among the foremost in the world.

The Chinese republic began its existence in 1912, when the child emperor, through the empress dowager, abdicated the throne.

Just off the mainland of Asia is a group of mountainous islands where live the most progressive native people of Asia. Japan is appropriately called the "Flowery Kingdom," and the "Land of Chrysanthemums." Everywhere are flowers.

The traveler from America can leave San Francisco on one of the great ocean steamers, and in a little more than two weeks arrive in Yokohama, the leading business center of Japan. Yokohama is the port of Tokyo, the capital, which is but eighteen miles distant. The first railroad in Japan was built in 1872, and it connects these two cities.

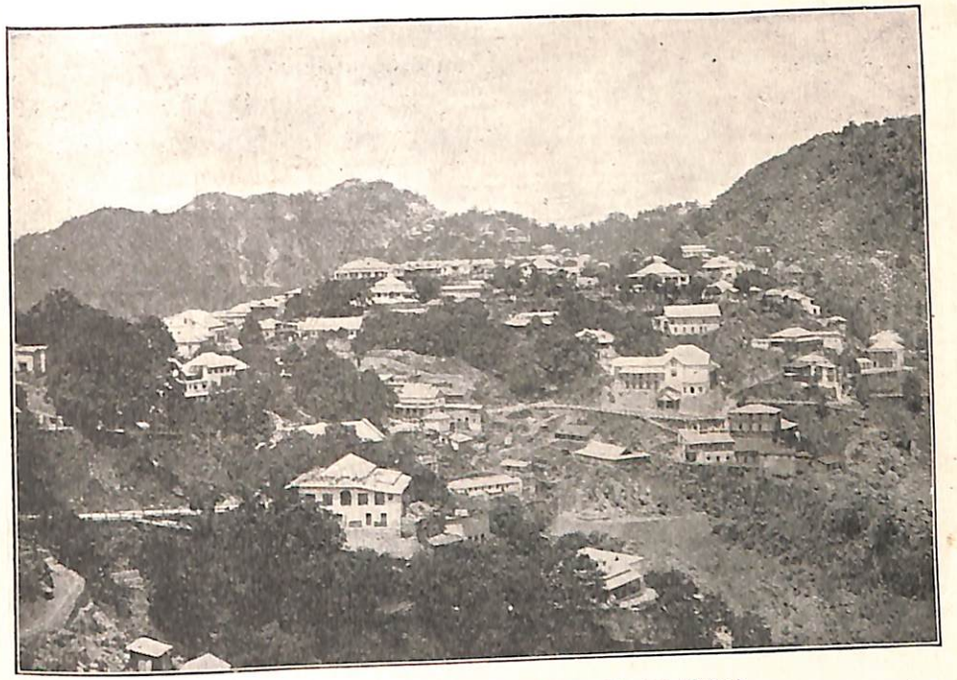
To the southwest of Yokohama rises a great conical mountain. In the clear atmosphere, it appears to be but a few miles away, but it is in reality sixty miles distant. Summer and winter it wears a crown of white. It towers above every other peak in the kingdom. It is the sacred mountain of the Japanese,— Fujiyama.



A BRITISH CONSULATE BUILDING

There are schools all over Japan, and in the large cities there are libraries, museums, hospitals, street cars, and electric lights, though these are not so common as in American cities. The buildings are very low. Frequent and severe earthquakes account for this.

The Japanese, as a nation, are noted for courtesy, which is everywhere manifested, from the lowly individual who sweeps the streets, to the members of the prince's household. They are quick to learn, and have made wonderful progress in manufacture



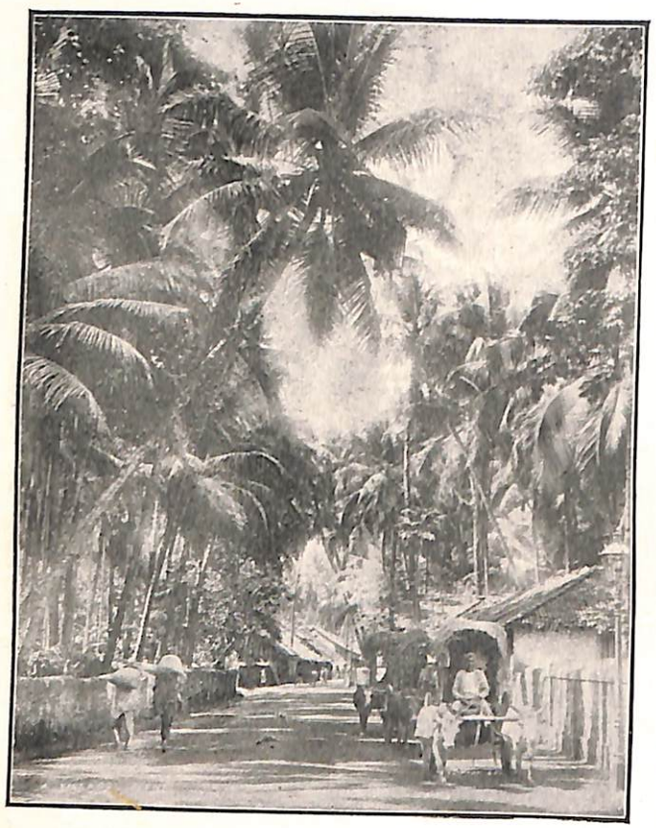
MUSSOORIE, A MOUNTAIN VILLAGE IN INDIA

during the past few years. Numerous large factories are producing machinery, woolen goods, and various articles for home and foreign trade.

Korea, a country as large as England, and containing twelve million population, was in 1910 added to the domain of the Japanese emperor, and the name was changed to *Chosen*. The Korean people are anxious to learn. They have sterling qualities, which place them, when educated, alongside any people in the world.

India is about half as large as the United States, and its population is about four times as great. The British govern this country. Most of the people live by agriculture. Manufacturing is rapidly developing in India, and iron and coal are mined there.

The British have built good roads in nearly all parts of India, and have made many thousand miles of railway. The foreign commerce is greater than that of any other Asiatic country. About half of it is with Great Britain, and much of the remainder is with China. Among the exports are cotton, jute, rice, opium, tea, hides, and wheat.



A SCENE IN INDIA

Calcutta, formerly the capital of India, is the chief seaport. Delhi is now the capital. Bombay is the largest city on the western coast.

Although for over a century missionaries from Europe and America have been giving the gospel to India, still there are millions in heathenism. The river Ganges, considered sacred by these people, is an object of worship. Thousands of the natives bathe in this river, hoping that this will rid them of sin.

Ceylon is a separate British colony. Among the chief products of this beautiful tropical island are tea, coffee, rice, fruit, and coconuts.

The countries of Indo-China also are awakening. This is a very productive region. Rice, sugar, spices, lumber, and tin ore are among the exports of these countries.

The city and island of Singapore, in the Straits Settlements, exports the larger part of the world's supply of tin. From a commercial and missionary point of view, Singapore is a great center. Many lines of steamships call there.

ENTERING THE JUNGLES IN SIAM

South of the mainland of southeastern Asia lies the East India group of islands. Strictly speaking, these islands belong to Asia; but the greater part of the group is under the rule of the Netherlands, and is known as the Dutch East Indies. However, most of the inhabitants are Asiatic — largely Malays, but there are many Chinese and a few Arabs. Europeans, the ruling class, form only a small part of the population.

The surface of the East Indies is mountainous, and there are many active volcanoes. The fringe of lowland coast plains and the river flood plains are generally fertile. In the larger islands are dense forests, mighty plains, and numerous rivers, abounding in animals wild and fierce, including elephants, rhinoceroses, lions, and monkeys. Some of the most delicious tropical fruits are found here in abundance. Rare and beautiful orchids are

obtained here by collectors, for conservatories in Europe and America. Rice is a staple article on some of the islands. Coffee, tea, spices, tobacco, and India rubber are produced and sent abroad. Mines of gold, coal, tin, and other minerals exist in the East Indies.

The greater number of the people are Mohammedans. In the interior of some of the islands there are many people as savage and unapproachable as the wild animals. They wait for the message of our heavenly Father's love, and many will rejoice to hear the glad tidings. As most of these islands are thickly populated, there is much to be done for them before the return of Jesus.

FILIPINOS FROM THE COUNTRY

The Philippine Islands are a colonial possession of the United States. There are more than three thousand islands in the group, but the bulk of the population is on Luzon, the largest island. The people are mostly Malays, though there are many Chinese, and a few Spaniards and Americans. These islands were discovered by the navigator Magellan, in 1521. Much of the surface of the Philippines is covered with dense tropical forests. The chief products are rice, sugar, Manila hemp, coconuts, and tobacco. Manila is the capital and largest city.

Questions

1. Compare Asiatic and European civilization.
2. Locate the agricultural areas of this continent, and account for the location.
3. Discuss the distribution of population. What races are represented? Locate them.
4. Contrast the governments of Asia and Europe. Name the most progressive native people.
5. What European nations occupy Asiatic territory? Locate the territory of each.
6. Discuss the manufactures and commerce of Asia.
7. Name the religions of this continent.
8. Give the names of missionaries who have labored in the different countries of Asia.
9. List the chief cities of the several countries, and tell an interesting fact about each.
10. List the Asiatic islands in order of size, and discuss the importance of each.

Requirement

Make a product map of this continent. Show highlands and rivers, also important cities and seaports.

Lesson XXXIX

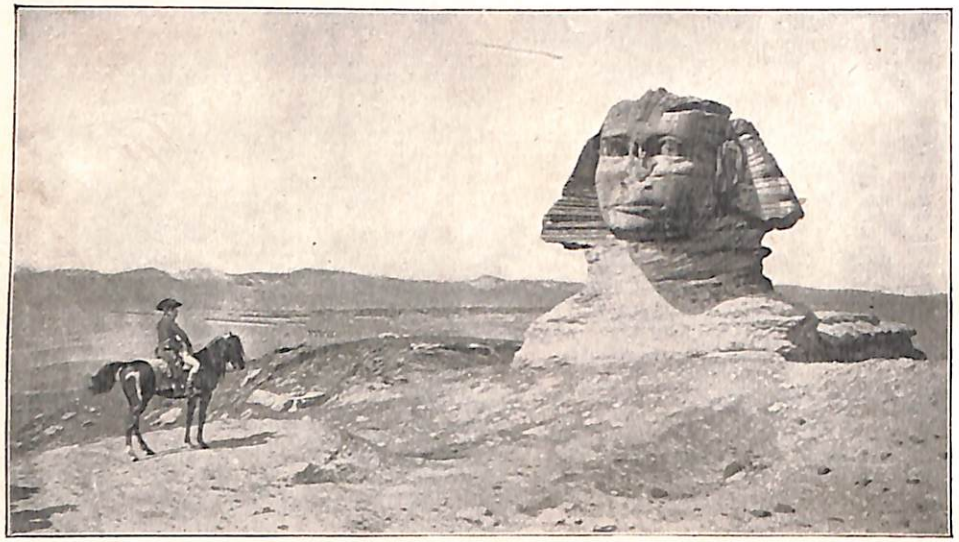
Map Study on Africa

Extent and Coast.— By what is Africa separated from the rest of the eastern continent, or Eurasia? What oceans border it? In what zones does it lie? Notice its extent of latitude and longitude. What American city has the latitude of the northern limit of Africa? Of the southern limit?

Compare Africa with the other divisions in regularity of coast line. Name straits, gulfs, and seas that border on this continent. Name the capes at the northern, eastern, southern,

and western extremities. What large island lies east of the continent? Find some oceanic islands west of the continent.

Surface and Drainage.— What part of Africa is mostly highland? Mostly lowland? Trace the continental divide. What slope of Africa contains the greatest rivers? Name its five great

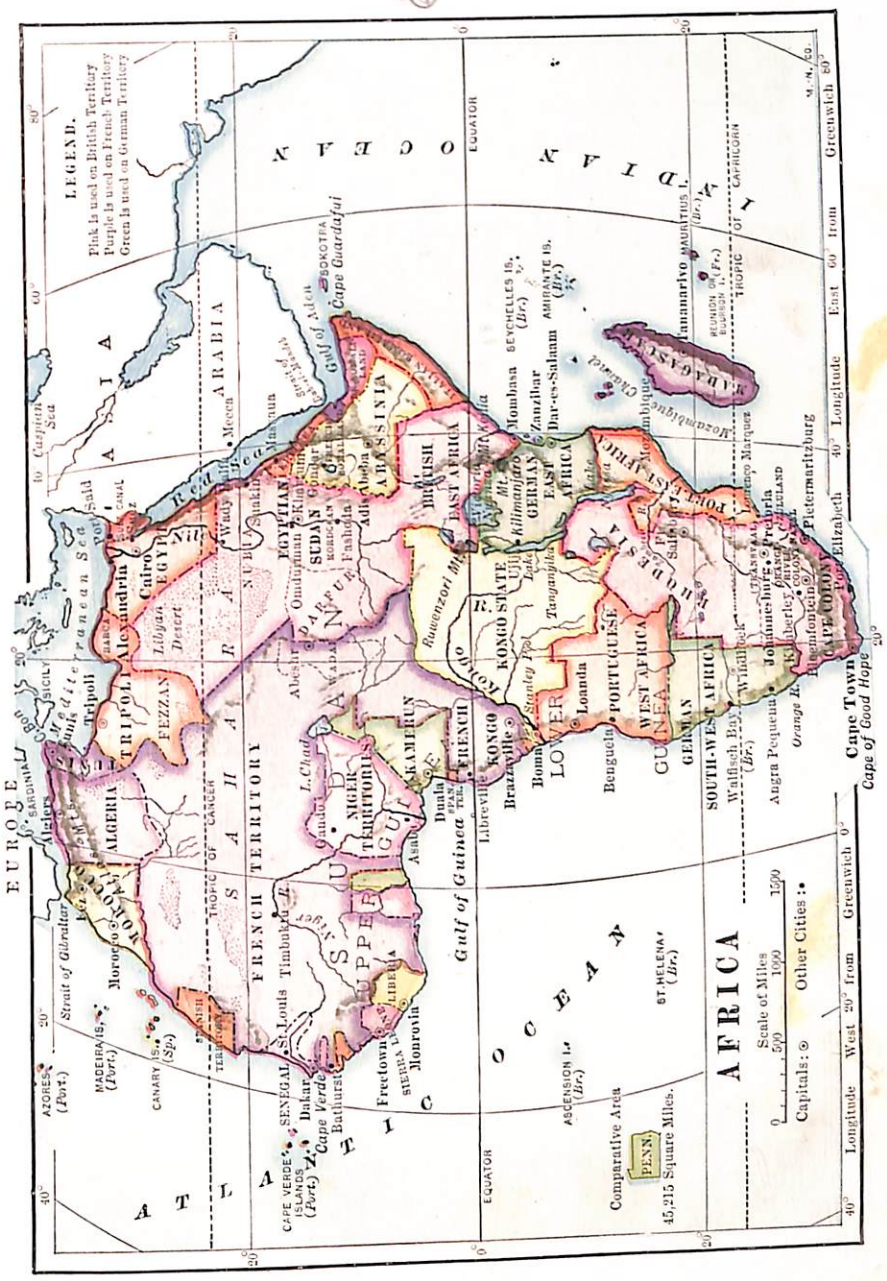


BONAPARTE BEFORE THE SPHINX

river systems. Name its large lakes. In what lake does the Nile rise?

People and Countries.— To what race do most of the people of central and southern Africa belong? What country of northern Africa has an ancient civilization? The other four states that occupy the Mediterranean coast are known as the "Barbary States." By what are these states bounded on the south? Which is traversed by the Atlas Mountains?

Locate the Sudan. Locate Abyssinia, Morocco, and Liberia. Why are the boundaries of many of the countries of Africa indefinite? What European nations claim the greater part of the continent?


LEGEND.
Pink is used on British Territory
Purple is used on French Territory
Green is used on German Territory
AFRICA
Scale of Miles
Capitals; ⊙ Other Cities ••
Comparative Area
PENN.
45,215 Square Miles.
Cape Town
Cape of Good Hope
Port Elizabeth
Pietermaritzburg
Johannesburg
Pretoria
Durban
Bloemfontein
Kimberley
Walfisch Bay
Windhuk
Angra Pequena
Orange R.
Zambesi R.
Mozambique
Beira
Quilimane
Tananarivo
MADAGASCAR
MAURITIUS (Br.)
SEYCHELLES IS. (Br.)
AMIRANTE IS. (Br.)
ASCENSION I. (Br.)
ST. HELENA (Br.)
AZORES (Port.)
MADEIRA IS. (Port.)
CANARY IS. (Sp.)
CAPE VERDE ISLANDS (Port.)
Dakar
Cape Verde
St. Louis
Timbuktu
Bathurst
Freetown
Monrovia
Libreville
Brazzaville
Loanda
Benguela
Mombasa
Zanzibar
Dar-es-Salaam
Kilimandjaro
Victoria Nyanza
Tanganyika L.
Nyassa L.
Stanley Pool
Kongo R.
Niger R.
Chad L.
Gaudar
Omdurman
Khartum
Abyssinia
Aden
Mecca
Cairo
Alexandria
Tripoli
Algiers
Morocco
Fez
Tangier
Gibraltar
Strait of Gibraltar
Cape Guardafui
Gulf of Aden
Red Sea
Suez Canal
Nile R.
Libyan Desert
Arabian Desert
Sahara
Soudan
Upper Guinea
Gulf of Guinea
Cameroon
Kamerun Mt.
Kilimandjaro
Ruwenzori Mts.
Abyssinia
Arabia
Asia
Europe
Mediterranean Sea
Caspian Sea
Black Sea
Bosporus
Dardanelles
Constantinople
Smyrna
Beirut
Damascus
Jerusalem
Euphrates R.
Persian Gulf
Bushire
Muscat
Bombay
Madras
Calcutta
Rangoon
Singapore
Java
Sumatra
Borneo
Celebes
Philippine Is.
Manila
Hong Kong
Canton
Shanghai
Pekin
Yokohama
Japan
Formosa
Australia
New Zealand
Sydney
Melbourne
Adelaide
Perth
Fremantle
Hobart
Tasmania
Wellington
Auckland
Christchurch
Dunedin
Fiji Is.
Hawaiian Is.
Honolulu
Sandwich Is.
Samoa
Tonga Is.
Marquesas Is.
Society Is.
Tahiti
Pitcairn I.
Easter I.
Galapagos Is.
Guayaquil
Lima
Callao
Valparaiso
Juan Fernandez
Chile
Peru
Bolivia
Paraguay
Uruguay
Buenos Ayres
Montevideo
Rio de Janeiro
Pernambuco
Bahia
Para
Manaos
Amazon R.
Orinoco R.
Trinidad
Barbadoes
Jamaica
Kingston
Havana
Cuba
Porto Rico
Haiti
Bermuda Is.
Nassau
Bahama Is.
Florida
Key West
Tampa
Pensacola
Mobile
New Orleans
Galveston
Texas
Mexico
Vera Cruz
Tampico
Acapulco
Mexico City
Guadalajara
Monterey
Rio Grande R.
Lower California
Gulf of California
Colorado R.
Arizona
New Mexico
Santa Fe
El Paso
Salt Lake City
Utah
Nevada
Carson City
San Francisco
Los Angeles
San Diego
Oregon
Portland
Columbia R.
Seattle
Puget Sound
Vancouver I.
Victoria
Alaska
Sitka
Yukon R.
Klondike
Dawson City
Behring Sea
Behring Strait
Aleutian Is.
Unalaska
Kodiak I.
Hudson Bay
Hudson Strait
Labrador
Newfoundland
St. John's
Nova Scotia
Halifax
Bay of Fundy
New Brunswick
St. John
Quebec
Montreal
Ottawa
Toronto
Lake Ontario
Lake Erie
Niagara Falls
Lake Huron
Lake Michigan
Chicago
Detroit
Lake Superior
Duluth
Minneapolis
St. Paul
Winnipeg
Manitoba
Saskatchewan
Alberta
Calgary
Edmonton
Athabasca L.
Great Slave L.
Great Bear L.
Mackenzie R.
Yukon Territory
Dawson City
Klondike

Name an ancient city at the mouth of the Nile. Find the capital of Egypt. What cities are at the termini of the Suez Canal? Name the capitals of Sierra Leone and Liberia. Make a list of the political divisions of Africa, with their capitals.

Note Book Requirement

Trace the outline of the continent of Africa. Trace the boundaries as far as possible, and insert the names of the various portions under French control. Represent this territory in one color. Bound and name the British possessions, and indicate them in another color. Name the German possessions, and color. Bound and name Italian, Portuguese, Spanish, and Turkish claims, coloring the territory of each nation in a separate color.

Lesson XL

The People and Countries of Africa

Ethiopia shall stretch out her hands unto God. Ps. 68: 31.

Africa is attached to Eurasia by an isthmus seventy-five miles wide. This continent is nearly three times as large as Europe.

The interior of Africa is a plateau, lower in the North than in the South. The coastal plain is broadest in the North, and west of the Sahara. In most other sections it is very narrow, but widens around the Guinea coast, and near the mouth of the Zambezi, where it is fringed by a region of tropical swamps.

The Sahara Desert occupies much of the northern part of the continent. This desert is almost as large as the continent of Europe, and is the largest desert in the world. The surface consists of sand dunes and great stony wastes. There are no roads or railways across this vast territory, and the only way to travel over it is on camels. There are so few oases that the watering places are far apart.

The Niger River forms an elbow in the Sahara in the South, and the Nile crosses the desert from south to north in the East. This is the only important river of Africa flowing northward.

The equatorial regions are hot and moist. Rain falls there at all seasons, and the lower lands are covered with dense, wet jungles, which are almost impenetrable.

To the north and south of this section the vegetation is less dense. The forests are more open, and form shady groves along the watercourses. These are the savanna lands of Africa.

There are fewer men of European descent in Africa than in any other continent. These are found mainly on the Mediterranean seaboard and in the extreme South. The Arabs and Berbers of northern Africa are descendants of Asiatic peoples. They belong to the white race. The largest part of the population of Africa are Negroes. There are many distinct tribes differing from one another in both appearance and language.

The inhabitants are numerous in the cultivated regions of the Sudan, and in some west African centers. In fertile Egypt, along the shores of the Barbary States, and on the richer savannas bordering the equatorial forests, the population is denser than in the extensive forest region; and naturally, the deserts are but sparsely populated.

Morocco in the Northwest, *Abyssinia* in the great volcanic highlands near the south end of the Red Sea, and the Negro republic of Liberia on the upper Guinea coast, are the only independent states. The rest of Africa is under the control of European powers.

Great Britain, France, Germany, Portugal, Belgium, and Italy are the chief nations holding northern and central Africa. The island of Madagascar is ruled by the French. Small islands in the Indian Ocean are British. Certain small islands west of Africa belong to Portugal, and others belong to Spain.

Much of south Africa was first settled by the Dutch of Holland. The English, however, got possession of Cape Colony long

ago; and as a result of war, they have since obtained possession of the other Dutch colonies.

Thus the nations of Europe are exploring and settling the continent of Africa, just as they explored and took possession of the New World.

South Africa has, from the very first, been particularly attractive to Europeans, on account of its climate. The Creator has enriched that land with wealth untold. From its mines, gold valued at many million dollars is taken each month. Here are the richest diamond mines of the world. Stones that attract world-wide attention, are obtained from the soft blue rock of southern Africa. Kimberley is the center of the diamond region. The district of which the city of Johannesburg is the center, produces more gold than all the mines of the United States.

NEGRESS AND CHILD, ALGERIA

In the Nile Valley, agriculture is the chief occupation, but the methods of cultivation are very primitive. Wheat, corn, cotton, sugar cane, rice, and semitropical fruits are grown in this fertile valley. In the Barbary States, which are too dry for agriculture, horses, mules, camels, sheep, and goats are raised. There is some hand manufacture in these northern countries, such as embroideries, shawls, and leather goods.

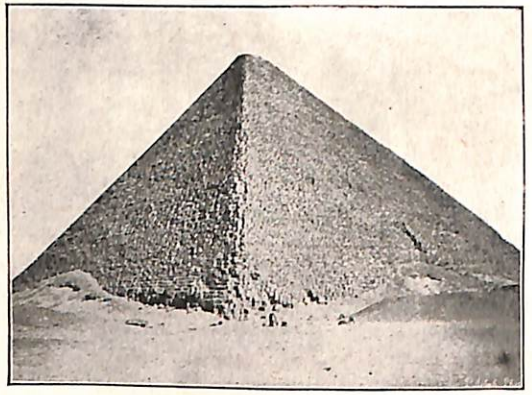
In central Africa the forests contain valuable woods, rubber-yielding trees, and trees yielding gums from which varnish is made. There is a palm from whose fruit is obtained a palm oil used in making soap. In these forests are herds of elephants,

and in the rivers are hippopotamuses. The tusks and teeth of these animals are exported as ivory.

The natives of the interior are generally more intelligent than those near the coast. They weave a cloth of palm fiber, and make rude canoes, bows, and arrows. Some cultivate the soil; others are fishermen.

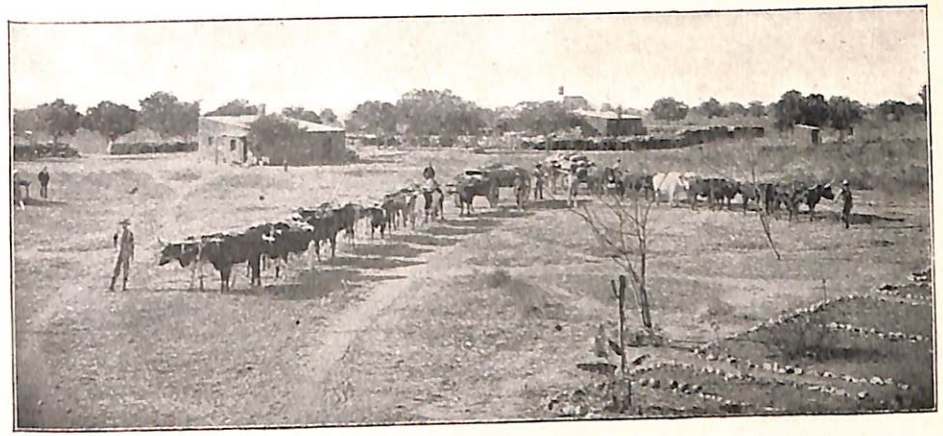
The exports from central Africa consist mainly of palm oil, ivory, varnish gums, hides, cabinet woods, and some cotton and coffee. The exports from south Africa are gold, diamonds, wool, feathers, goats' hair, hides, and copper ore.

Cape Town is the capital and chief port of Cape Colony. Cairo, the capital of Egypt, is the largest city of Africa. Near it are the great pyramids, built thousands of years ago, when Egypt was the center of the learning and civilization of the world. Alexandria is the most important seaport of Egypt. Tunis is the largest city of the Barbary States.



GREAT PYRAMID IN EGYPT

Mohammedanism is the principal religion of northern Africa, and the native tribes of the interior are in pagan darkness. In that land of sunshine and showers, of delicious fruits and beautiful flowers, of vast forests and sunny fountains, the natives of many languages wait for the light of God's word. There are those who are becoming conscious of their need. Among these are the Ugandas, a bright native people living upon the shores of the great Victoria Nyanza. These and other tribes show an anxiety to learn, and are calling for teachers. In the providence of God, the opening up of this continent has been undertaken, and will be carried forward until



MISSION SCENE IN AFRICA

many "gems for His kingdom" will be gathered from the "golden sands" of darkest Africa.

Questions

1. Contrast Africa and Europe in size, surface, and climate.
2. Describe the vegetation in equatorial Africa.
3. Where are the savanna lands of that continent?
4. What race of people predominate in Africa?
5. What peoples of the white race live there?
6. Locate the regions of densest population.
7. Name and locate the independent states.
8. What European powers dominate northern and central Africa?
9. By what European nationality was south Africa first settled? What nation now holds possession of that territory?
10. What are the chief attractions of this region to Europeans?
11. What are the industries of northern Africa? The exports?
12. Mention the leading exports of central Africa. Of southern Africa.
13. Name and locate the principal cities of Africa. Give an item of interest regarding each.
14. Why has Africa been long known as the "Dark Continent"?
15. What is the chief religion of northern Africa?
16. What is the religion of the native tribes of the interior?
17. What progress is the gospel making among the people of this continent?

Lesson XLI

Australasia and Its People

The Lord reigneth; let the earth rejoice; let the multitude of isles be glad. Ps. 97:1.

Map Study.— What tropic crosses Australia? Is any other continent wholly in the Southern Hemisphere? What obstacle to navigation extends along the northeast coast? What is the largest river system? Locate Sydney and Melbourne.

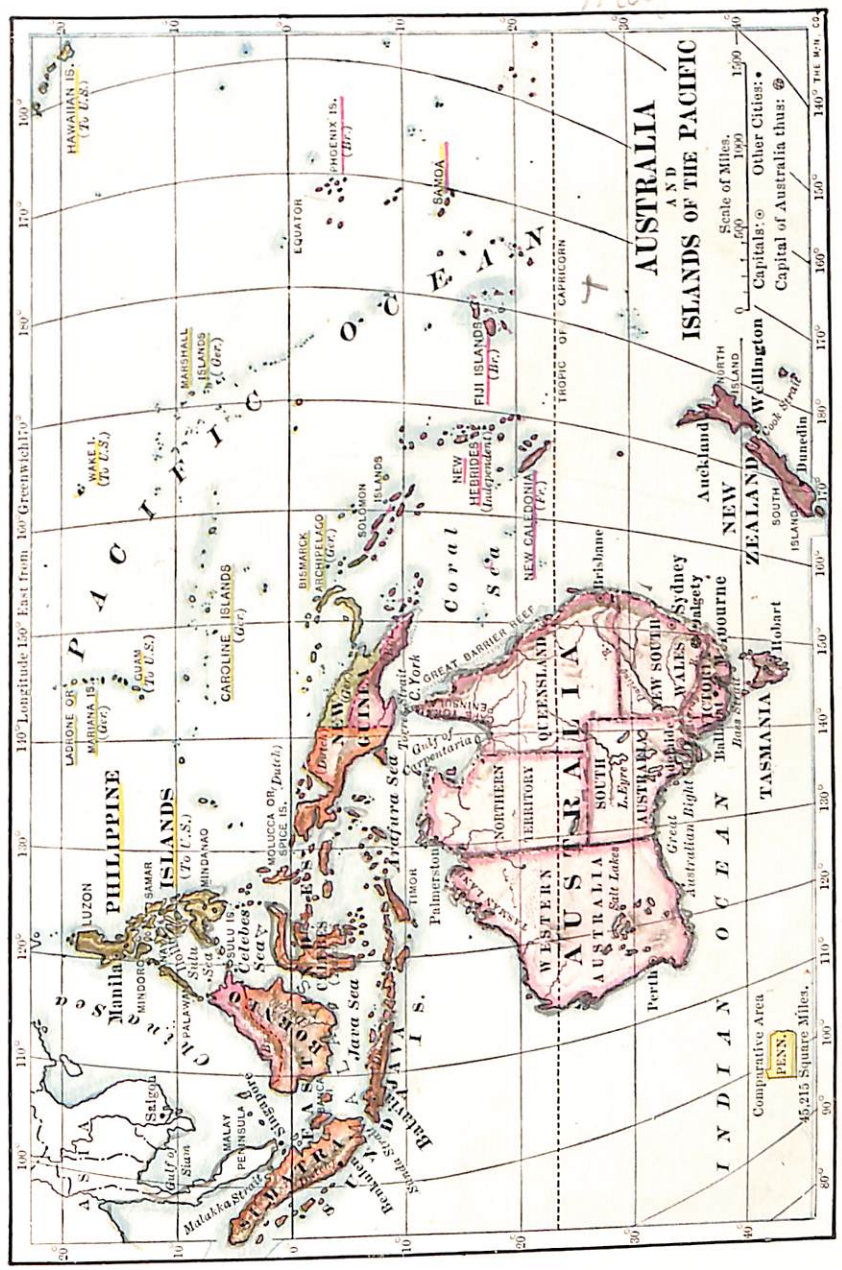
Australia lies seven thousand miles southwest of San Francisco, and some fifteen thousand miles southwest of London. To reach Australia, from San Francisco, a sea voyage of about three weeks is required; and if the journey is made from London wholly by water, it occupies nearly twice as much time.

Although the smallest of all the continents, Australia measures about two thousand miles from north to south, and two thousand four hundred from east to west. In general the surface of the country is flat. Most of the eastern half is a low plain, which rises eastward to a narrow rim of highland.

The southeast trades bring moisture in all seasons to the steep eastern slope, and there are many short but beautiful streams along the east and north coasts. But on the whole, Australia is deficient in rainfall, and much of the interior is desert. Northern Australia is tropical and densely wooded.

This is the most sparsely peopled of all the continents. When the Europeans came to settle Australia, they found a black-skinned people there before them. These native Australians are probably of mixed origin. They have either wiry or wavy hair, and the men usually have beards. They are a hunting people, and are at a very low stage of civilization.

The discovery of gold between 1850 and 1860 attracted many prospectors to New South Wales and Victoria; and the present population is almost entirely composed of settlers from the



British Isles, or their descendants. Over a third of the inhabitants live in the capitals of the six states.

The white man can not make his home with profit in the rich, wet northern forests; but on the eastern coastal plain, sugar is cultivated in the North, corn in the central region, and wheat still farther south. Dairy farming is profitable in the southern section, and sheep farming on certain large central and western areas. Sheep, cattle, horses, pigs, camels, and other useful animals were brought to this continent by the Europeans. Besides gold, the Australian mines produce silver and copper.

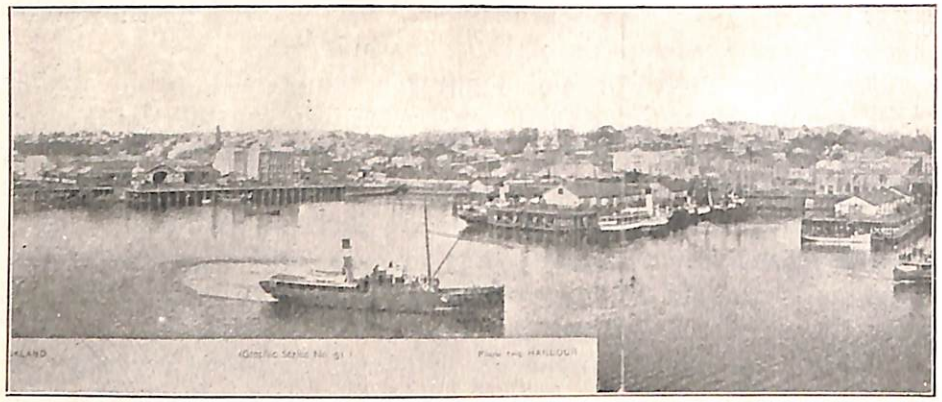
Aside from the mining centers, all the principal cities are on or near the seacoast. They are well laid out, and made beautiful by large parks. Some of these parks contain a great variety of trees, brought from all parts of the world. Sydney and Melbourne have large libraries.

In each of the colonies, the capital is the center of all commercial activity. Numerous short lines of railroad have been constructed near the coast, but only a few railways penetrate far into the interior. Australia is connected with Eurasia, Africa, and America by telegraph cables.

The chief articles of export are wool and meat. Australia furnishes much of the gold supply of the world, and yet the yearly product from all the mines of the continent is not nearly so valuable as the pastoral and farm products.

The island of Tasmania, nearly two hundred miles south of the southeastern portion of Australia, is a part of the Australian commonwealth. It has been called the "Switzerland of the South," because of its mountainous surface. Its mountains are

ON THE ROAD TO MARKET — AN AUSTRALIAN SCENE



AUCKLAND HARBOR.

thickly forested, and its plains are fertile. Numerous sheep farms stud the country. Copper, tin, silver, and gold are mined for export, and coal for domestic use.

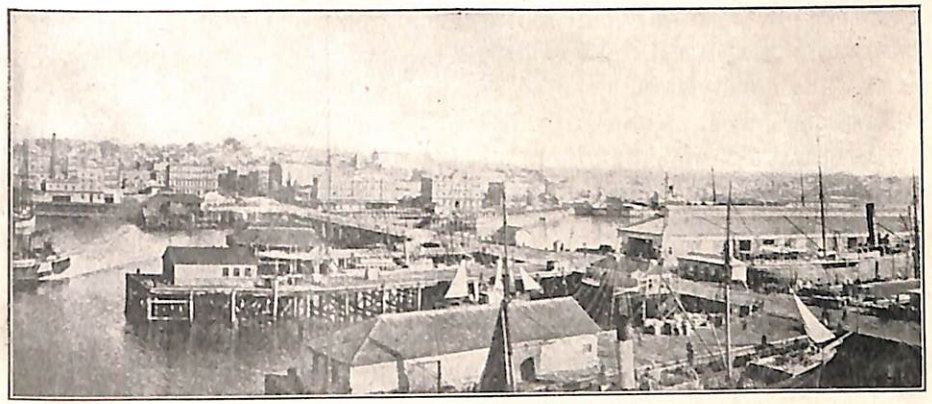
Hobart, the capital, is beautifully situated, and is a summer resort for people from Australia.

New Zealand consists mainly of two large islands, and is an independent British colony. Its largest city, Auckland, is its principal port, and Wellington is its capital.

This is a land of boiling lakes, awe-inspiring geysers, and Alpine scenery. The climate is excellent, resembling that of Italy. Flowering shrubs and beautiful flowers adorn the hills and the gardens.

Western New Zealand is forested, while the eastern part is grassy land, cultivated here and there, but used mainly for sheep grazing. The mineral wealth is great. Gold and coal are the leading products of the mines.

New Guinea is a large island directly north of Australia, which rises above the same continental shelf. It is the second largest island in the world, being about three and one half times as large as Great Britain. England, Germany, and Holland all claim this island. Except along some parts of the coast,



NEW ZEALAND

where a few white people have settled, it is inhabited by the black race. Very little has been done to develop the resources of the island, although the lowlands are very fertile.

The Fiji Islands were discovered in 1643, and ceded to England in 1874. There are about two hundred islands in the group, some eighty of which are inhabited. These beautiful and fertile islands once contained a savage race. Until less than fifty years ago, this was perhaps the worst cannibal country in the world. But all is now changed, and life is as safe here as in other lands. Through the work of faithful missionaries, the Fijians have yielded to the peaceful influences of the gospel, and have turned from their horrible practices and savage instincts.

At Suva, the capital of this group, considerable business is carried on, and this is one of the foremost island centers in the south Pacific.

The Samoan Islands are mountainous. They are well watered, forested, and fertile. Missionaries have a foothold here also, and the natives are partially civilized. The two largest islands of this group belong to Germany. Tutuila is a naval station belonging to the United States.

Other islands of the south Pacific appear upon the map of

this section. They seem to be arranged in long parallel rows extending northwest and southeast. Some are volcanic groups, others are coral islands. The vegetation consists largely of cocoanut palms, bananas, breadfruit trees, yams, and sugar cane. On the larger volcanic islands, such as Fiji and Hawaii, rice, sugar, cotton, and other crops can be profitably grown.

The natives are mostly of the Malay race. They have become somewhat civilized by contact with European and American peoples, and especially have they been benefited by the work of self-sacrificing missionaries. Many noble men and women have given their lives for the cause of Christ upon these islands. Find out what you can about the work of Paton, Williams, and other missionaries to the islands of the Pacific.

GRAVES OF MISSIONARIES

The Hawaiian Islands lie in the north tropical Pacific, about one third of the distance from San Francisco to Sydney. As nearly all vessels crossing the Pacific call at Honolulu, the capital of the group, the city has been termed the "Crossroads of the Pacific." Perhaps nowhere can be found finer pictures of sea and sky, brighter sunshine, with tempering breezes, and more fragrant foliage.

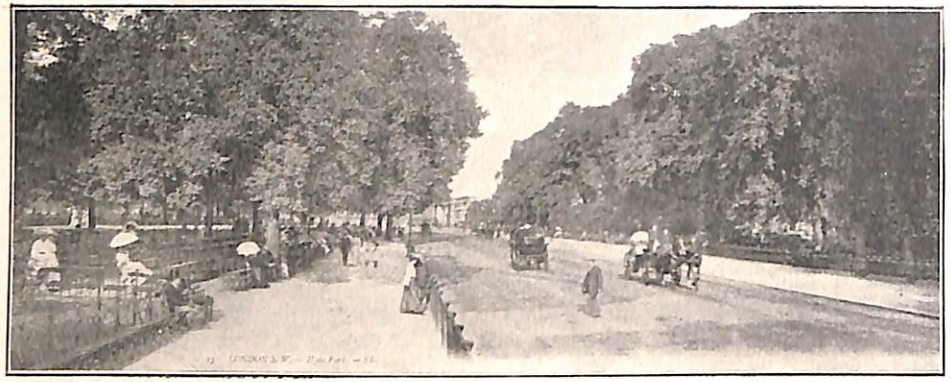
The principal industry is sugar manufacture. Millions of dollars is invested in sugar plantations, and thousands of men are employed upon them. The pineapple industry also has recently been developed, and other tropical fruits are grown for export. In 1898 the Hawaiian group was annexed to the United States as a territory.

Questions

1. Compare Australia with other grand divisions as to size.
2. Describe the surface and the vegetation.
3. In what wind belts does Australia lie? How does this affect the distribution of moisture?
4. Describe the aborigines of that continent.
5. Account for the present European population.
6. Explain the distribution of settlers, and describe the industries.
7. Why is Tasmania called the "Switzerland of the South"?
8. For what is New Zealand noted?
9. Name and describe some of the island groups of the south Pacific.
10. What city has been termed the "Crossroads of the Pacific"?
11. Name and describe the large cities of Australia.
12. Why is it now much safer to visit the islands of the south Pacific than formerly?
13. Name missionaries to these islands.

Note Book Requirement

Trace the outline of Australia and of the islands southeast. Insert boundaries of states upon the continent. Name the states, and locate the capital of each. Locate the capital of Tasmania and that of New Zealand. Name prominent groups of islands in the south Pacific. Color all British territory pink.



HYDE PARK, LONDON

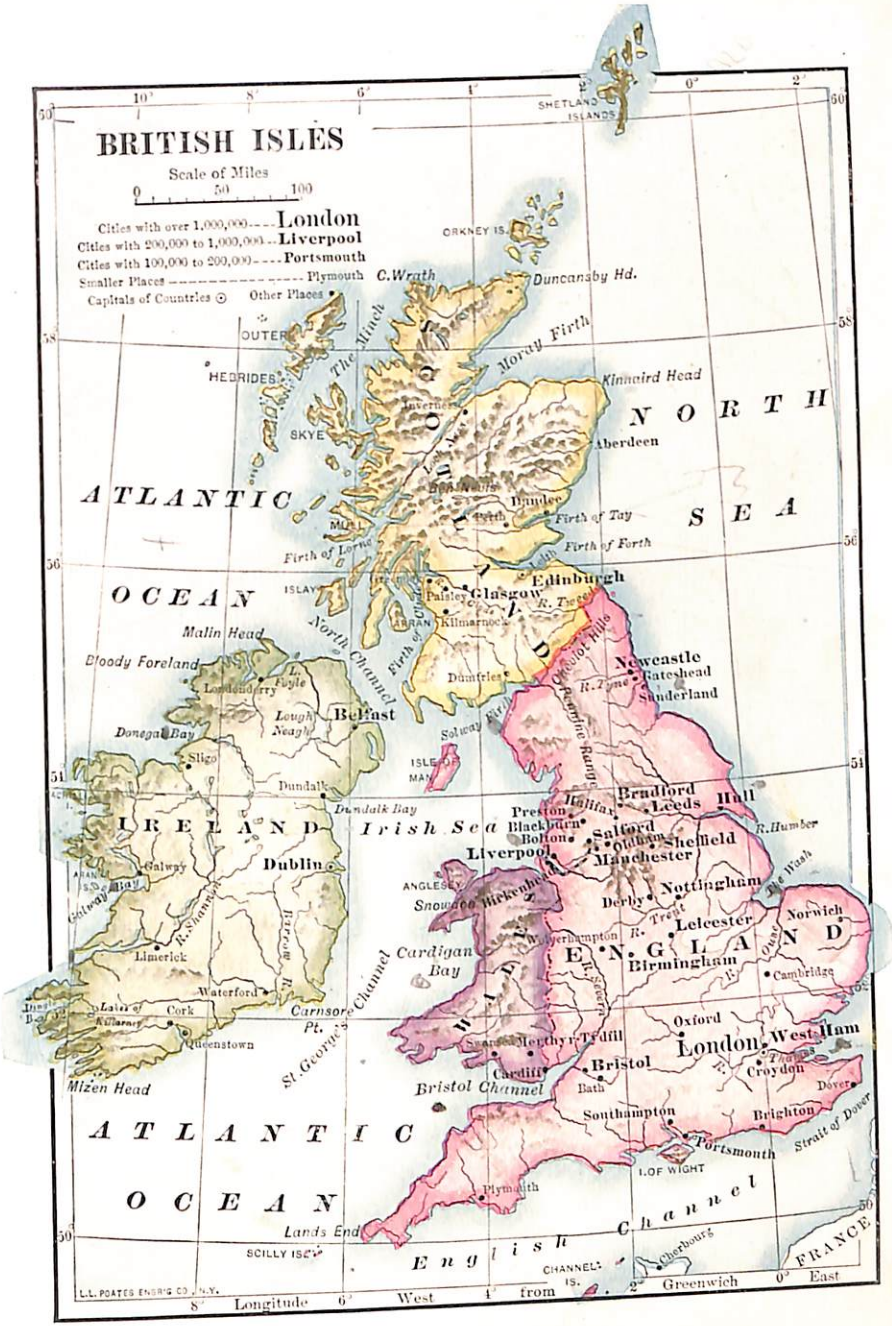
Lesson XLII

The British Empire

Map Study.— By what waters are the British Isles surrounded? Name the two largest islands, and the water between them. Name three groups of islands north of Great Britain; one group south. Name three indentations of the east coast of Great Britain; four of the west coast; three of the west coast of Ireland. In what part of the British Isles are there highlands? Name three rivers of England; two of Scotland; two of Ireland.

Just off the western coast of the European continent, surrounded by the English Channel, the Strait of Dover, the North Sea, and the Atlantic Ocean, lies a group of islands that without doubt once formed part of the mainland of Europe. The similarity between the opposite shores of Great Britain and the continent may be seen in the chalk cliffs of Kent and France.

The British Isles possess many advantages that have combined to fit them to be the home of one of the most enterprising and powerful nations the world has ever seen. First of all, notice the position of this group as related to the great land



masses of earth. A map of the continents shows that the British Isles occupy one of the best geographical positions of the world. They lie almost in the center of the land surface of the globe, and are washed by the Atlantic Ocean, the great highway of commerce.

Then again, while that country enjoys all the advantages that follow from its position opposite the most industrious and densely populated parts of Europe, it has benefited by being an island group, in that it has not been affected by the wars and pestilences which have devastated the continent.

This island country is known among the countries of Europe by the name of the *United Kingdom of Great Britain and Ireland*. It is much smaller than the home country of any other of the great powers; but the British have long been the most successful colonizers in the world. During the past three hundred years, they have planted colonies in every one of the grand divisions and in many islands of the sea, so that now Great Britain is the mother country of a world-wide empire, upon which the sun never sets, the area of which is ninety times that of the home land.

The British Empire consists of the United Kingdom, and her colonies, dependencies, and protectorates in every part of the world, comprising upwards of one fifth of all the land on the globe, and one fourth of the population. These extensions give to the British Empire an area of nearly four Europes.

Excluding certain small possessions that are chiefly of the nature of naval or military stations, it includes, besides the United Kingdom, four great groups of territory inhabited to a large extent by Englishmen subject to the crown, and a fifth great territory, also subject to the crown and ruled by English officials, but inhabited by a foreign race.

The first four groups are as follows: (1) the Dominion of Canada; (2) the West Indian Islands, among which are included some territory on the continent of Central and South America; (3) the mass of South African possessions, of which Cape Colony

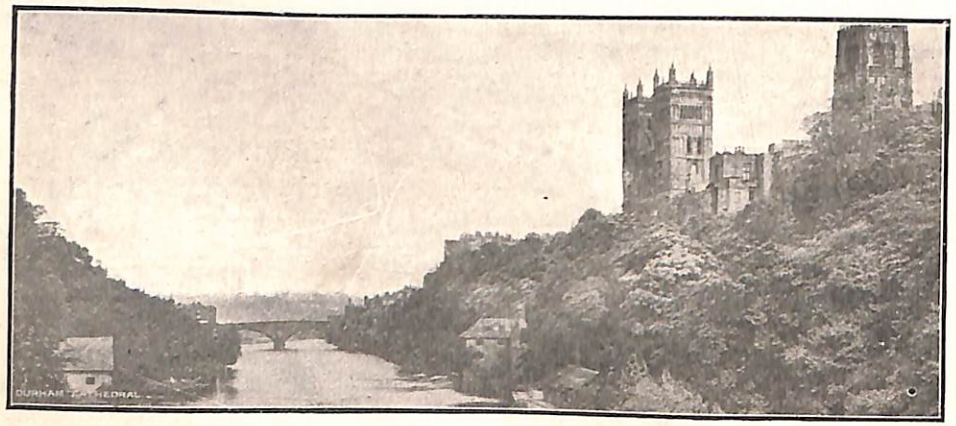
is the most considerable; and (4) the Australian group and New Zealand. The fifth great territory is the dependency of India.

A *dependency* is a foreign possession, inhabited, for the most part, not by those who are akin to the people of the ruling state, but by an alien population. Thus India is rightly called a dependency, while New Zealand is not a dependency, but a colony.

A *protectorate* is a country under its native rulers, over whom the home government exercises a limited control, and with whom other nations are not allowed to interfere. There are several British protectorates in Africa.

These British possessions have been acquired in different ways. Some have been obtained by right of discovery, as Newfoundland; some by settlement, as Australia; others have been taken by force from other nations, as Gibraltar from the Spaniards, Canada from the French, and Cape Colony from the Dutch; still others have been obtained by treaty or purchase.

The British Isles are densely peopled. Manufacturing is the main industry, especially in England. Only a small part of the people are engaged in agriculture and pastoral pursuits, and food of all kinds must be imported. In northern and south-



DURHAM CATHEDRAL

western England, and in southern Wales, the coal fields yield nearly as much coal as do the coal beds in the United States. Other mines yield iron and tin.

The abundant supply of coal is the chief encouragement for manufacturing. Supplies of raw material, such as cotton, wool, and hides, are imported in large quantities from beyond the sea. The importing of this material and of food supplies, and the exporting of manufactured goods and coal, give rise to a foreign commerce nearly twice as great as that of any other country. This, besides much of the foreign trade of other countries, is carried on British shipping; for Great Britain owns nearly half the ships of the world.

London, the capital, is the largest city in the world. It lies on both banks of the Thames, which is crossed by many bridges. The harbor, formed by the broad estuary of the river, is fifty miles long. The trade of London is mostly with Asia and the European mainland, and the imports greatly exceed the exports.

Glasgow is the second city of the kingdom, and is the center of Scottish trade. Steel ships, machinery, cotton and linen cloth, carpets, and pottery are the leading manufactures.

Liverpool, the third city, is an active commercial center, and the great seaport for the manufacturing section of England. The

LONDON BRIDGE

commerce of this port is largely with America, South Africa, and Australia. The exports are chiefly cloth and hardware, and the imports are cotton, wool, and foodstuffs. The region across England from Liverpool is an almost continuous succession of great manufacturing cities. Among these, Manchester is the world's greatest cotton manufacturing center. Leeds is noted for its woolen manufactures, Birmingham and Sheffield for machinery and hardware. Newcastle and Cardiff are great shipbuilding and manufacturing centers. Belfast is famed for Irish linen manufacture, also for shipbuilding.

Questions

1. What advantages of location do the British Isles enjoy?
2. By what name is the island kingdom known?
3. How much is included in the term "British Empire"? What great groups of territory?
4. Define a dependency; a colony; a protectorate. Give an example of each.
5. State ways in which British possessions have been acquired. Give examples of each.
6. Discuss the industries and trade of Great Britain.
7. Locate the chief manufacturing cities, and state the principal manufactures of each.
8. What portion of the inhabitants of the world are ruled by this great power?
9. What influence have the English-speaking peoples exerted upon the world's civilization?
10. What has been the influence of the English people in the spread of Christianity?

Note Book Requirements

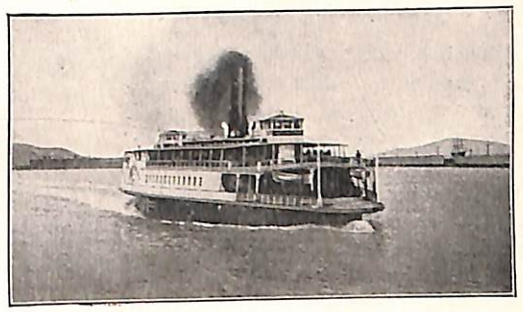
1. Upon a Mercator's projection indicate with colors all territory of the world ruled by the British Empire. Color also all other territory governed by English-speaking nations. What portion of the earth's surface is covered?
2. List the important cities of the British Isles and other territory ruled by the British Empire, and indicate the location of the same upon the map.
3. List missionaries from the United Kingdom famous for their work in heathen lands.

Lesson XLIII

The Commerce of the World

The commercial map of the world aims to give a picture of the routes of trade. Notice the railroads upon the continents, and the steamship lines crossing the oceans.

Commerce enables men to exchange the goods they produce, or that may be produced in the region they inhabit, for goods not found there.



A FERRY STEAMER

Means for overcoming the barriers to communication and trade have had much study by all the great nations of earth. In the earliest ages, man made use of certain animals as beasts of burden. He utilized the force of the wind to move his ships. In addition to this, he now summons to his aid steam and electricity. Railroads have been laid from shore to shore on the continents. Mountains have been tunneled, and wide rivers bridged. Canals have been cut from one river basin to another, affording highways for transportation.

Easy routes from one country to another have been mapped out, and many obstacles have been overcome in shortening these routes of trade. The careful charting of the ocean highway, and the establishment of lighthouses along the coasts by the governments of the different marine nations, has vastly lessened the dangers of ocean commerce.

By means of trade, the mineral wealth of the world and the riches of the forests have been gathered to serve human need. Many varieties of plants and animals have been taken to locations where they were not native, and have been acclimatized.

Indian corn has been carried by man throughout the warm lands of both hemispheres. The same is true of other plants, as cotton, rice, and sugar cane.

There is an increasing demand, among the people of the Temperate Zones, for the products of the tropics. The European wants sugar, spices, rubber, oils, fruits, woods, hemp, and other tropical products. This constant demand accounts for the widespread invasion of the tropics by Europeans. They are in search of the wealth of the tropics, and they carry to the inhabitants of the tropics the manufactured articles of the home land.

To exchange the surplus of one country for the products of another, is the chief end of commercial intercourse. The value of trade depends upon the supply of various products and the demand for them.

In international commerce, actual cash payments are comparatively small, most of the business being done on an extensive system of credit and bills of exchange. The system of banking and credit involves the establishment of banking houses throughout the world.

The business of foreign exchange is largely centered in certain great cities. New York, Chicago, San Francisco, London, Paris, Berlin, Vienna, Bombay, Hongkong, Canton, Cape Town, Melbourne, Sydney, Rio de Janeiro, Buenos Aires, and Valparaiso are prominent financial centers. A commercial and financial center is such largely by reason of its location with reference to the productive areas of the country, and because it commands adequate transportation facilities.

The steamship is the chief ocean carrier at the present time, although a large number of sailing vessels also are constantly engaged in world commerce.

Among the great ocean thoroughfares of the world are the following:—

The Transatlantic Route.— This is the route between the United States and European ports. The westward passage lies north of the eastward.

The Mediterranean Route.— This is the route to the East from Europe, and across the Atlantic from the United States to Gibraltar, thence through the Mediterranean to the Red Sea by way of the Suez Canal, and on to India. China, Australia, and east African ports.

The Pacific Ocean route is between western North America and Hawaii, the Philippines, Japan, China, New Zealand, and Australia.

The Cape Horn route is by the east coast of South America, around Cape Horn, to the ports of western America and Australia.

The Cape of Good Hope route leads down the west coast of Africa, and around the Cape of Good Hope, to the ports of east Africa, Australia, and eastern Asia.

Many lines of steamships regularly traverse these routes. Let us trace a steamer from London by the last named route. It will make a run of over 1,400 miles in about five days, and stop at Tenerife, on the Canary Islands. From this point to Cape Town is a voyage of about fifteen days. The next calling port is Hobart, Tasmania. This place is about seventeen days from Cape Town. The steamer leaves Hobart headed eastward across the south Pacific, rounds Cape Horn, and continues up the eastern coast of South America to Rio de Janeiro, accomplishing this long run in about three weeks. The homeward journey from that port to London requires another three weeks, and the circuit of the globe has been made.

The vast system of land telegraphs throughout the world is of great importance to commerce. Orders for goods are telegraphed from city to city across the continents. It was in 1846 that the public use of the electric telegraph began. A few years later, the first Atlantic Ocean cable was laid, and now business between different countries is largely carried on by means of the submarine telegraph.

There are nearly two thousand submarine telegraph lines. The Atlantic is many times crossed by cables laid on its floor, and the coast of every continent outside of the Arctic and the

Antarctic regions is traversed by submarine cables. Since the completion of the cable between the United States and the Philippines, by way of Hawaii, Wake Island, and Guam, there is continuous telegraphic communication around the earth. The total length of the world's telegraph lines is more than one million miles, and the total length of the single wires amounts to the enormous sum of about four million miles. Over these lines more than a million messages are sent daily, directing the trade of nations.

Wireless telegraphy has been made a successful means of communication between points widely separated. It was in 1901 that Marconi, the inventor of the wireless telegraph, succeeded in his attempts to signal from Cornwall, England, to St. John's, Newfoundland. Successful communication by wireless telegraphy has since been established between widely separated countries. A wireless station costs much less than a submarine cable covering the same distance. For this reason wireless telegraphy, whenever it can be used for long distances, is much the cheaper. It is in quite general use on ocean steamers, where it is of especial value, as it enables vessels to communicate with each other and with stations on land when the ships are hundreds of miles from shore. Wireless telegraphy is invaluable in lighthouse service, especially for use on board lightships.

Countries that lead in the world's commerce are Great Britain, Germany, and the United States. England and Germany, by an intelligent development of their resources, have made their manufacturing industries so efficient that much raw material is imported to their factories. In order to place their manufactures on the world's market, and secure foodstuffs for their dense populations, they have each developed an extensive commerce.

The exports of the United States greatly exceed the imports, and European countries rely largely upon the United States for their food supply, and for raw material for manufacture. Hence the foreign commerce of the United States is constantly enlarging.

Just as the Suez Canal was the natural outcome of the trade between western Europe and the Orient, so the Panama Canal is the natural outcome of the trade in the New World. The shifting of so large a part of the financial interests of the world to the western side of the Atlantic, demands a direct route from this new commercial center to western South America and western Asia. This canal is destined to prove of great importance to the world of commerce in general.

Questions

1. Define *commerce,* and distinguish between domestic and foreign.
2. What is a marine nation? Give prominent examples.
3. What has been accomplished through trade?
4. Give the reason for the invasion of the tropics by Europeans.
5. Locate three North American centers of foreign trade; four European; two Australian; two Asiatic; two African; two South American.
6. Describe five regular routes of travel. Estimate the distances.
7. Where are railroads numerous? Where are they few? Account for the present distribution of railroads.
8. What is the probable future influence of the Siberian railway upon the Suez Canal? Of that canal upon the Cape Horn route?
9. Contrast Europe and Africa with regard to natural advantages for trade.
10. What geographical facts have helped to make Great Britain a carrier for other nations? Germany?
11. What can you say of the importance of the Hawaiian Islands in the trade of the Pacific?
12. Is there any likelihood that the center of maritime trade will shift from the Atlantic to the Pacific as it once shifted from the Mediterranean to the Atlantic? Why?

Note Book Requirement

Upon a Mercator outline, locate the chief centers of commerce, and indicate the most important routes of ocean travel.

CHAPTER VI

PLANTS

(Scripture Basis, Gen. 1:11, 12)

"And God said, Let the earth bring forth grass, the herb . . . and the fruit tree."

Lesson XLIV

Living Matter

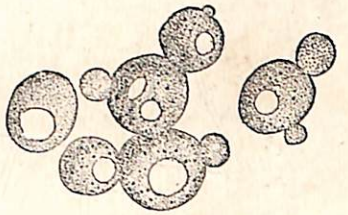
For with Thee is the fountain of life. Ps. 36:9.

A grain of sand has no life. It is dead. It can not move. It can not change its form. This is true of all mineral matter. We may place the sand under a microscope and examine it ever so closely, we may look at it daily for a year, and it will be just the same lifeless material. It can not grow larger, and it can never divide itself into other grains of sand. It can not move of itself. It is simply a lifeless particle of mineral matter.

Look at some tiny seeds. They may be as small as the grains of sand at your feet. They certainly are hard and lifeless looking as they burst from their ripened seed pod; but it will not take you long to discover that there is life within. Give to the seed the right amount of warmth and moisture, and the testa will crack, the germ of life awaken, and a tiny plant unfold.

Even those plants that are so minute that they must be studied under the microscope in order to discover whether they are plants or animals, are all possessed of life and power to grow and multiply.

The plant may consist of a simple closed sack, or cell, as does the yeast plant. Inside this cell there is a jellylike liquid called *protoplasm*. If we watch these yeast plants under the microscope, we can see them changing form. Little knoblike swellings appear upon the parent plant. By and by these will separate themselves and become other yeast plants. This is because the yeast plant is alive, and, like every other living thing, it is able to grow and reproduce its kind. A single drop of yeast will, in a very few hours, form millions of new plants, each growing to full size.



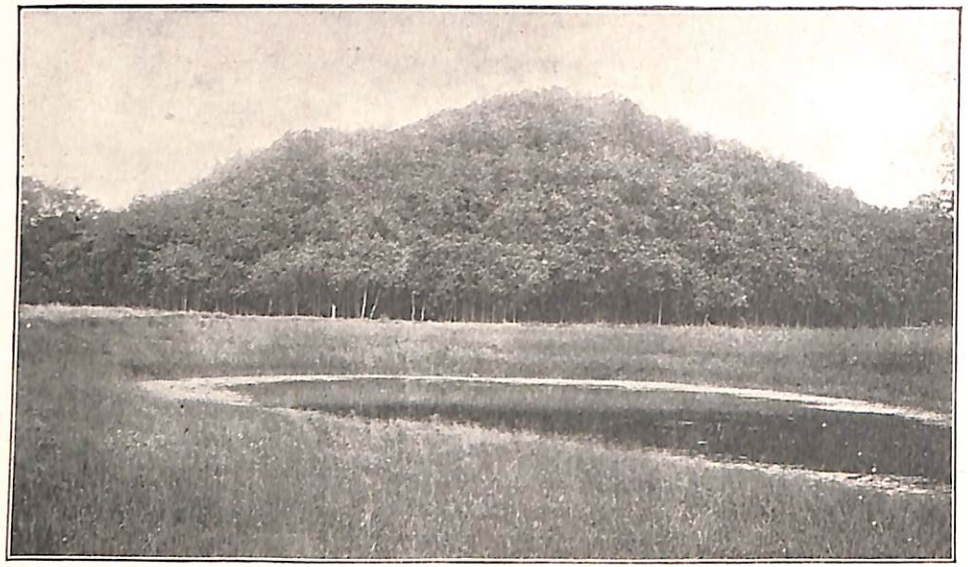
GROWING YEAST PLANTS

Showing method of formation of buds on the sides of the cells

The cell is the unit of life. All plants are composed of cells. A plant that is large enough to be handled is made up of a multitude of cells grown together, each of which is or has been alive.

Break off the outer layers of an onion or any other bulb. Between the parts there is a thin film, which, if placed under the microscope, will plainly show the cellular structure of plant tissue. If a drop of iodine is added, the nucleus, or more dense portion of the protoplasm, will clearly stand out. The nucleus is the life center of the cell, and every cell of protoplasm has its nucleus. A strand of corn silk laid under the microscope will show currents of protoplasm flowing from cell to cell, and carrying food materials.

No plant can grow without food. The protoplasm, which is the living part of the cells, must have both food and water. Even the microscopic one-cell plant must have the proper quantity of food, or it can not grow.



BANYAN TREE, CALCUTTA

One curious thing about a plant is that it can feed and thrive upon elements that nothing but a plant can change into living material. Can man, or any other creature of the animal kingdom, live upon the elements of matter taken directly from earth, air, and water? The plant can. It can take from the soil certain substances, such as lime, soda, and potash. It takes from the air a gas that is absolutely poisonous to animal life. It is the work of the plant cells to change this material into living food with which to nourish their own life, and to attain as nearly as possible that degree of perfection with which the Creator caused the plants to come forth from the earth in the beginning.

If the plants did not make food, there could be nothing alive in the world. So plants are made to grow out of the earth, translating the lifeless elements of the mineral kingdom into the living plant tissues of the vegetable kingdom. From the vegetable state they can then be changed into the animal kingdom.

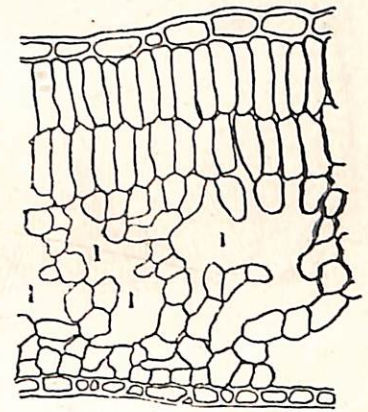
Experiments

1. Fill a bottle with well water. Add a little sugar, and stir a little white of an egg into the water. Now put a drop of fresh yeast into the bottle, and set the bottle in a warm place. In a few hours the liquid becomes whitish in color. This is because millions of new yeast plants have formed from the few put into the bottle.

2. Examine a grain of sand under the microscope; also sections of plant tissue. Compare.

Questions

1. To what three kingdoms does all matter belong? Illustrate each by an example.
2. State the difference between living and dead matter.
3. Describe the yeast plant.
4. What is protoplasm?
5. How does a plant differ from an animal? What is the essential difference?
6. Explain how the vegetable kingdom is the connecting link, as it were, between the mineral and the animal kingdom.
7. How are those who are "dead in trespasses and sins," translated into the kingdom of life? Eph. 2:1; Col. 1:13.



SECTION OF LEAF SHOWING CELLS

Note Book Requirement

Upon page 44 explain and illustrate the experiments suggested in this lesson.

Lesson XLV

Soils

But other fell into good ground, and brought forth fruit, some an hundredfold, some sixtyfold, some thirtyfold. Matt. 13:8.

The ideal soil is a reservoir to receive and hold enough moisture to supply the needs of crops. It must contain sufficient

SCHOOL GARDEN

plant food, in such form that the water can dissolve it and thus prepare it for transfer to the living plant tissue.

On the other hand, the soil must not be kept too wet, as this drowns the roots and excludes the air. A living root consists of living cells, not one of which can live long without air. Hence the ideal soil must be porous enough to admit all the air the roots require.

Most garden and farm soils consist principally of a mixture of clay and sand.

If we separate the clay from the sand, and examine each, we shall find that sand is heavy in weight. The particles are large, admitting much air. Water runs through it rapidly, and does not climb back very far.

Clay consists of very small particles. Water runs through it slowly, and climbs back many feet. Although clay contains plant food, its particles cling too compactly together when entirely alone, and are too cold for plant growth. Such a soil must be loosened and made warm by adding sand and *humus*.

Humus is a porous substance, rich in food products, that is always formed where decay in animal or vegetable matter is well advanced. The ground at the bottom of a hollow in the forest, where the leaves have gathered and decayed for centuries, consists largely of humus.

Whenever a farmer or a gardener adds vegetable or animal matter to his soil, and permits it to decay there, he makes it richer in humus. This enables the soil to hold more water than would otherwise be possible, and it also prevents the surface of the soil from baking.

Sandy loam contains more sand than clay. Such soils dry rapidly, and do not always hold sufficient water to sustain plant growth. Clay loams consist mainly of clay, and they retain the water much better.

An ideal soil must contain enough clay and humus to hold water and lead it toward the surface. It must contain sand enough to let the surplus water move downward. It must contain enough humus and clay to furnish food for the plants. It must contain enough humus to keep the soil from baking — that is, hardening and drying. And it should contain sufficient sand and humus to keep the soil porous and warm.

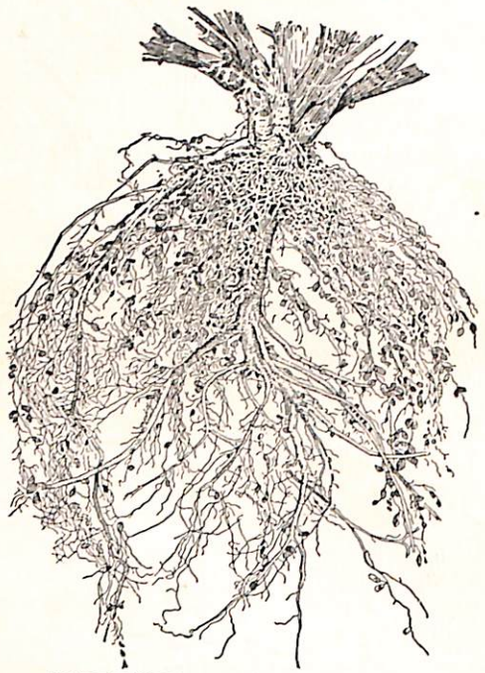
Sometimes the soil needs lime, not often to furnish food to the plants, but because the soil becomes sour, so that many plants will not grow well in it.

Now water will dissolve from the soil large quantities of mineral matter. Even the richest soil may become exhausted if the farmer continues to raise crops on his land without returning any mineral matter to it. In that case we say that the soil becomes "poor"; that is, there does not remain enough of some mineral matters to feed plants well.

The three substances of which the soil is most often robbed are nitrogen, phosphoric acid, and potash. Of these three things, nitrogen is the most important, and the farmer needs to return nitrogen to the soil. You will remember that nitrogen is a gas, forming the larger part of the air about us; and yet nitrogen can not be taken directly into the plant, for it is not in the right condition. The nitrogen in the air must first unite with certain substances in the soil, and thus form what are called *nitrates*, before the plants can use it for food.

There are two ways in which nitrogen is gathered from the air and given back to the soil. The first is by the addition of humus, which gives off much nitrogen in ammonia. This nitrogen was previously absorbed from the air by the plants which, in decomposing, form the humus.

The other way is very curious indeed. There are certain minute plants — bacteria — which, unlike other plants, have a way of making use of the nitrogen from the air. Perhaps no one knows just how they do it, but they gather the nitrogen from the air surrounding the roots of certain plants, among which are the clovers.



TUBERCLES ON CLOVER ROOTS

Pull up a clover plant, and you will discover for yourself little white bunches on the roots. They are not much larger than the head of a pin, and you might not notice them if you had not been told to look for them; or you might think that some insects or disease germs were at work. But not so. Within these bunches grow thousands of tiny bacteria. They are not robbers; they are tenants, as it were. The clover plant furnishes them a home, and in return they give to the clover some of their nitrogen in payment of their rent.

Nor is all the nitrogen that is thus gathered, needed by the clovers. The farmer may harvest a good crop of clover, rich in nitrogen, and still leave more nitrogen in the field than was there before the clover grew.

If a crop of corn or wheat follows the clover, it can not get more nitrogen in the way that the clover did, but it can use what the clover left, and thus grow much better than it could if the clover had not grown there and furnished a home for the nitrogen-gathering bacteria.

Clover is not the only plant that the bacteria assist in this way. Peas, beans, and other plants that belong to the legume family, have the same assistance. On the roots of the cowpea the bunches are much larger than they are on the roots of the clover.

All crops that furnish a home for nitrogen-gathering bacteria are useful in enriching the soil. Can not these plants teach us a lesson about helping one another?

Experiments

1. Take three lamp chimneys, and cover the bottom of each with netting. Fill one with dry sand, one with clay, and the other with soil from the garden. Stand each chimney over an empty tumbler, and pour the same amount of water into each at the same time. Note the progress of the water through the soil.

2. Arrange the chimneys, and fill as before with dry soil, in one putting sand, in another clay, and in another soil from the garden. Fill a shallow pan with water, and stand the chimneys in the pan. Watch the water make its way upward through the soil particles.

Questions

1. What relation has an ideal soil to water? To air?
2. Of what do most garden and farm soils consist?
3. Contrast sand and clay.
4. What change is made in a clayey soil when sand is added?
5. How would you improve a sandy soil?
6. How would you add plant food to a clayey or adobe soil?
7. What is humus? and how is it added to the soil?
8. Of what use is lime to the soil?
9. Account for the excess of water-soluble matters in arid regions.
10. Explain why irrigated lands nearly always give better crops.
11. What is meant by "poor" soil?

12. What are the three substances of which soil is most often robbed?
13. Explain two ways in which nitrogen is returned to the soil.
14. What lesson do you learn from the nitrogen-gathering bacteria?

Requirements

1. Make drawings illustrating the foregoing experiments.
2. Make a collection of soils.

Lesson XLVI

Seeds

So is the kingdom of God, as if a man should cast seed into the ground; and should sleep, and rise night and day, and the seed should spring and grow up, he knoweth not how. Mark 4: 26, 27.

"In the heart of a seed, buried deep, so deep,
A dear little plant lay fast asleep.
'Wake!' said the sunshine, 'and creep to the light;'
'Wake!' said the voice of the raindrops bright.
The little plant heard, and it rose to see
What the wonderful outside world might be."

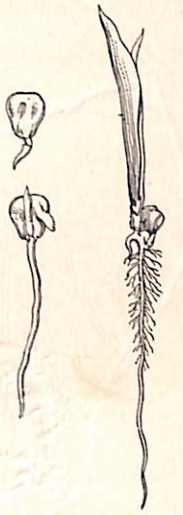
Without seeds, many kinds of plants would soon pass away, for there would be no young plants to take the places of those that die.

Let us get a few seeds of squash, some beans, and a few kernels of corn, and see what they will tell us about themselves. We have already studied beans and squash seeds; but we will examine them again by way of review, and in order to compare them with the corn seed which we wish you to study particularly at this time.

Every perfect seed contains a plantlet, and some food to nourish the plantlet during germination. A dry seed may lie

for years apparently dead. If we add a little water, it soon rids itself of its coat, and the young plant begins to grow.

We will place the seeds that we wish to study, in a seed tester. This may consist of a common table plate, covered with a pane of glass, and two pieces of rather thick cloth. Wring the cloths out of water, leaving them moderately wet. Place one cloth over the bottom of the plate. Spread the seeds upon this, and cover them with the other cloth. Put on the cover, and set the tester in a warm place.



SPROUTED SEED AND SEEDLINGS

The seeds will soon become greatly swollen, as they take in, or absorb, some of the water from the cloths.

If we examine the grooved side of a soaked kernel of corn, and compare it with an unsoaked kernel, we shall find that the groove has become partially filled up. Why is this? Just as soon as water enters the seed, activity begins; and the germ of life in the kernel of corn lies just under this groove.

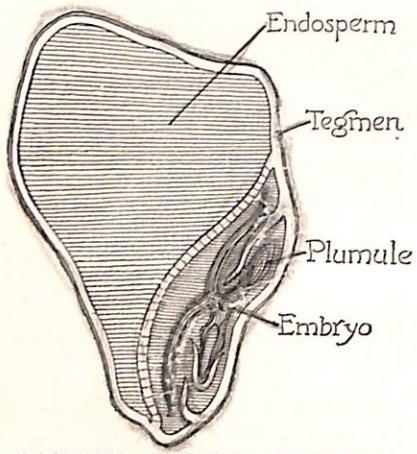
Let us remove the thin, tough skin from a soaked kernel, and notice its transparency. This skin, the bran of unsifted corn meal, does not exactly correspond to the *testa* and *tegmen* of the bean and the squash, since the kernel of corn, like all other grains, represents not merely the seed, but also the seed vessel in which the seed was formed. In the bean, the seed vessel was a pod; in the squash, it was the large, hollow fruit that held the seeds.

The *embryo*, or young corn plant, is the dense white portion just under the groove, which is of a cheesy consistency. This is the corn plantlet. If split lengthwise and examined closely, a slender, somewhat conical *plumule* may be seen.

The yellow portion, or that which in some kernels is white and floury, is called the *endosperm*. In the kernel of corn, we do not find the two cotyledons, or seed leaves, as we do in the

bean and the squash; but instead we have a simple cotyledon inclosed in the endosperm. The cotyledons of the bean and the squash seeds furnish food for the plantlets hidden between them. In the corn, the endosperm is the food of the *embryo,* which it waits to nourish.

The endosperm does not rise above ground when the kernel is planted. Most of it remains in the buried grain, and acts as a digesting and absorbing organ from which the nourishment in the endosperm is transferred to the growing plant, as fast as it can be made liquid for that purpose.



MAGNIFIED SECTION OF KERNEL OF CORN

The bean and the squash are dicotyledonous plants, while the corn is monocotyledonous.

Experiments

1. Into a glass of hot water, drop various seeds, to find out where the openings are in each seed. (Bubbles of air will rise from the openings.)

2. Get three chalk boxes, and fill each with garden soil. Moisten for planting. In the first box, plant three rows of Windsor or Lima beans, laying the beans of the first row flat on the soil, those in the middle row with the hilum or scarred end up, and those in the last row with the hilum down. Push all the seeds just half way down in the soil.

In the second box, arrange similarly three rows of soaked squash seed.

In the third box, arrange three rows of corn similarly and at the same time. Watch the sprouting seeds, and note results from day to day. Why do some of the seeds sprout more easily than others?

3. From several kernels of corn that have fairly started to grow, carefully cut away the endosperm. Place these upon mosquito netting over a glass full of water; place also sprouted kernels from which you have not attempted to cut the endosperm. Watch these plantlets for several weeks, and note results.

4. Test the endosperm for starch. Test the embryo. Test other seeds for starch.

Questions

1. What is a seed? Of what use are seeds?
2. What is germination? How is it started?
3. Of what use is the micropyle in germination?
4. What does the embryo plant need for growth?
5. What is the chief use of the cotyledons?
6. Of what use is the endosperm in a kernel of corn?
7. Why does not the covering of a kernel of corn correspond to the testa of a bean, or the testa and tegmen of a squash?
8. Name other monocotyledonous plants besides the corn.
9. In monocotyledonous seeds, what becomes of the cotyledon?
10. What becomes of the cotyledons in the dicotyledonous seeds?
11. What does the germination of the seed illustrate? John 12:24, 25; 1 Cor. 15:35-39.

Note Book Requirements

1. Sketch an unsoaked kernel of corn so as to show the grooved side, where the germ lies.
2. Cut sections of soaked kernels, and sketch, labeling the embryo and the endosperm in each sketch.
3. Make several sketches to illustrate the growth of the plumule, and the development of the roots from the caulicle of the seed. (Make these sketches from your own sprouted kernels.)

Lesson XLVII

The Garden

And the Lord God planted a garden eastward in Eden; and there He put the man whom He had formed. Gen. 2:8.

In the beginning, "the garden of Eden was the schoolroom, nature was the lesson book, the Creator Himself was the instructor, and the parents of the human family were the students."

PLATTING AND SPADING THE GARDEN

It is not strange that in the education which is now carried forward, the cry, "Back to the soil," should be sounding; for although the earth is blighted with the curse, the Creator's plan is that nature be made our lesson book, and the garden our schoolroom. This lesson book, in connection with the Scriptures, will lead to an acquaintance with the God of nature, whom to know is life eternal.

A great many children all over the land are planting school gardens this year. These should become real laboratories for nature study, and real lesson books that shall impress the words of the divine Teacher.

It is not always the size of the garden that counts most. Suppose that the space assigned you this year is only three feet wide and four feet long. Even upon this small plat a variety of crops can be grown, and many lessons can be learned from your experience.

First of all, unless the ground has been plowed, you will find a spade or a spading fork useful in working the soil. Try to loosen it six or eight inches deep. Get rid of the stones and clods. If humus is necessary, stir in about two inches of dry, decayed manure. This will give better results than chemical fertilizers, though chemicals will help if you can not get the other.

Before you are ready to sow the seed, make a diagram of your plot, and indicate what you wish to plant in it. You might put at four inches from one end a row of radishes. Eight inches from that, you can plant a row of lettuce. Eight inches from the lettuce, you can put a row of parsley or onions; a foot from the parsley, a row of beets. There will be room for one more row one foot from the beets, and that might be planted to beans. Turnips can be sown after the radishes and lettuce are gone.

In a small garden, one must be careful to plant only things that will grow in a small space. Such vegetables as corn, potatoes, and tomatoes should not be grown next to the radishes and other low-growing plants.

An ideal garden plot in a temperate latitude should slope gently toward the south, in order that the rays of the sun may fall more directly upon it; and in planning the rows, have them run north and south, so that the sunlight will fall upon the plants from all sides. Tall-growing plants are best grown on the north, so as not to shade others.

In order to be certain that your seed bed is in condition for planting, fill the hand with soil, and squeeze it a bit. If, upon opening the hand, the impression of the fingers is left on the soil, and it crumbles readily, it is ready for the seeds.

The first thing to do is to make the furrow. One good way to mark a furrow is to stretch a string where the row is to be, and dig the trench with a hoe. Another way is to use a board as a guide, drawing the hoe along its edge.

The method of planting has much to do with the results obtained. Small seeds must not be deeply covered with earth; for if they are, the plants that they contain will not be strong enough to reach the light and air. Large seeds, however, which contain quite a quantity of stored food material, may be planted deeper. The following rule may be safely followed for all seeds commonly planted on the farm and in the garden: All seeds of plants that come up without thick seed leaves, as Indian corn and all other grasses, also peas and lentils, may be safely covered to ten times their thickness. Other seeds should not be covered to more than five times their thickness. Thus depth of planting is regulated by the habit of germination of the seed.

When planting, hold the seeds in the left hand, and sow with the right, keeping the hand close to the trench, so as not to scatter the seeds. After sowing, cover, and press down with a hoe blade or with a board. This will bring the moist soil into close touch with the seeds, and thus assist their germination. Time will be gained by soaking such seeds as peas, beans, and onions twenty-four hours before planting.

At the head of each row you plant, put a small stake labeled with the name of the seed and the date. Later, as the plants appear, write on the stake the date when they come up. If you make these stakes in your manual training department, you can have them exactly as you want them. Make them all the same size, and paint them all the same color.

In addition to your school garden, plan to have a home garden, and be sure to take as good care of the one at home as you do of the one at school. Besides the lessons that your garden can teach you, much good can be done with the returns that come from marketing vegetables for missions. As we garden, let us remember that —

"'Tis God, our heavenly Father, that made each little seed,
And puts away within it the tiny plant we need;
And then He gives us our part to find the plant within,
And when we add our work to His, we find what is therein."

Experiments

1. Fill a box with dry soil. Water, and stir it at once. Fill another box with dry soil, and after watering, set the box aside. Stir the soil in the second box the next day. Which is the better way?

2. Before planting your seeds, take ten or twenty of the kind that you expect to plant, and place them in the seed-testing device previously explained. Every twenty-four hours observe the condition of the seed. Count the seeds that do not germinate. If one out of ten of the seeds thus tested does not germinate, what fraction, or per cent, would be lost? Reject seeds where more than ten per cent fail to germinate.

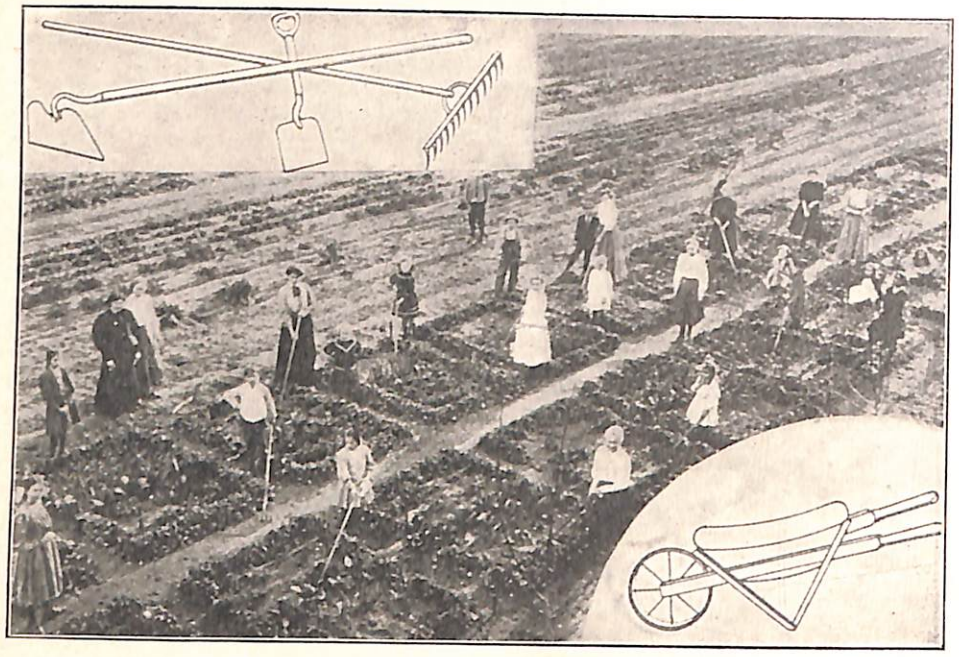
Seeds may fail to germinate from four causes: (1) Too old. (2) Having become musty in storage. (3) Having been frozen before they became dry. (4) Not having been perfectly formed.

Questions

1. What place had gardening in earth's first school?
2. What place may it now have?
3. How can you prepare a garden bed for warmth? For air? For food? For sunshine?
4. Why should seeds not be planted while the ground is wet?
5. Why should tall-growing plants not be planted next to low-growing plants?
6. In planting the garden, how should the rows run? Why?
7. Give two methods for marking the rows.
8. Give a rule for depth in planting. What regulates the depth?
9. How many of the seeds tested and planted in your garden are dicotyledonous? How many are monocotyledonous?
10. Compare the seeds thus far studied, as to their habits of "coming up."
11. How may we hasten the germination of seeds?
12. Who causes the earth to bring forth? Isa. 58: 11.

Requirements

1. Make a drawing of the garden plot described in this lesson, to the scale of one inch to one foot.
2. Make similar drawings of your individual school garden plot, also of your home garden plot, if you have one.



AT SCHOOL — IN THE GARDEN

Lesson XLVIII

Care of Seedlings

Thou shalt be like a watered garden, and like a spring of water, whose waters fail not. Isa. 58: 11.

When the seeds in your garden begin to "come up," you will need to watch the little plants closely. You must see that the seedlings have sufficient water, and a fair chance to get a start.

If young plants become spindling, they are too close together, or perhaps they need more light. If too close together, they should be thinned out; and if in a box, it should be placed where the plants can receive more light.

The best time to thin out the young plants is after the true leaves have formed. The smallest and weakest plants should

be pulled out, care being taken not to disturb the remaining plantlets.

The kind of root and the kind of stem and leaves a plant has, tells us how far apart to thin the seedlings. For instance, when the root grows straight downward without branching, as do the roots of wheat seedlings, the plants will grow and mature much closer together than when the roots branch and mass together as they do upon the corn. Thus wheat is planted close together because of deep roots, and corn is planted far apart because of surface roots, which would otherwise crowd one another.

Plants with such roots as the beet, should be thinned to a distance equal to the diameter of the mature root. Lettuce and cabbage, which form above ground, should be as far apart as the distance across the mature heads.

When the soil becomes too dry to feed the plantlets properly, the garden must be watered.

Now there is a right way and a wrong way to water your garden. The right way is to wet the garden thoroughly. The wrong way is simply to sprinkle the surface. If your plants are in rows, the best way is to dig a deep trench between the rows, being careful not to disturb the roots of the young plants, and irrigate the plants by filling the trench full of water. After the ground is thoroughly soaked, the trench should be covered. The water sinks below the roots, and they grow downward to seek it. Sprinkling the ground encourages surface roots. Such roots can not grow so well, nor endure the hardships that roots well set in the ground can withstand.

If plants are grown broadcast, and it is necessary to sprinkle in order to water the seedlings, one must be sure to drench the bed completely. Sprinkling the plants each day is a sure way to spoil them.

It has been said that it is better for the garden if the gardener will work the watering can less, and the hoe more. In this way, the upper soil is made to serve as a loose blanket

to prevent the loss of moisture, and it is not necessary to water so frequently. This is because water rises more slowly through a layer of crumbled soil; and since evaporation occurs almost entirely at the surface of the soil, this crumbled layer greatly hinders evaporation, and saves the soil water.

A hard rain always makes the soil pack more or less. When the surface begins to dry, it should be hoed and raked to a depth of about three inches, and the crumbled soil will keep the water from escaping.

Plants try to produce seeds, in order that more plants may grow. If a plant is allowed to go to seed, it usually stops growing flowers. If the flowers are picked before going to seed, the plants will send out more blossoms. Hence, to keep your plants blooming, pick your flowers daily.

Each flower on a plant needs food, which the parent plant has to furnish. The parent stalk can furnish more food to two flowers than to twenty. Therefore if you wish to grow perfect flowers, pick all the forming buds but a few. These will get all the food the plant can furnish, and will grow into large and beautiful blossoms. This process is called *de-budding*.

Seedlings are often transplanted. This is usually done when the plant is but a few inches high, just after the true leaves have come out.

Take up the seedlings with the least possible injury to the tiny roots, getting as much dirt as you can. Make a hole large enough to receive the roots easily. Insert the plant and the soil that clings to it, without cramping the roots. Holding the plant with the left hand, carefully pack fine, moist soil about the roots with the right hand. Water thoroughly, and shade the plantlets for a time, unless you do the transplanting toward evening or on a cloudy day.

Questions

1. What are the needs of a growing seedling?
2. Explain the right way to water your garden.

3. When is the best time to thin out young plants?
4. What three things determine for us how far apart the plants must grow?
5. Why is it well to "work the hoe more than the watering can"?
6. How soon after a rain should the garden be hoed and raked?
7. What is the main effort of a plant?
8. How can you assist the plant in the production of extra-large flowers?
9. What is de-budding?
10. What is transplanting? Explain the process.

Note Book Requirement

Write a composition upon roots and their needs, and copy into Note Book. (See Book 2, page 149.)

Thurs

Lesson XLIX

Growing Plants from Buds

Let us get up early to the vineyards; let us see whether the vine hath budded, and its blossom is open, and the pomegranates are in flower. Song of Solomon 7: 12, A.R.V.

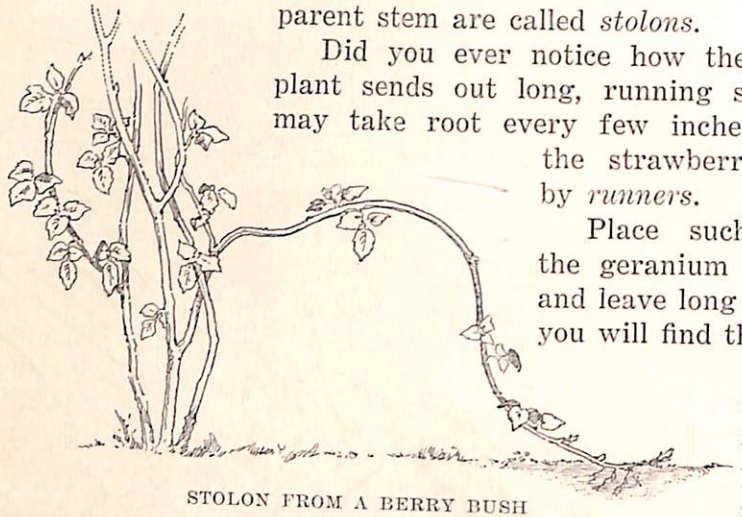
There are some kinds of plants that are reared more easily from buds than from seeds.

Go into the garden in the summer, and you will find erect shoots, or sprouts, growing near certain bushes and trees. Such shoots are called *suckers*. They have not developed from seeds, but from buds that the parent stem has sent out to form new plants.

SUCKERS FROM A ROSEBUSH

On some plants, where long, trailing branches touch the soil, you will

notice that there springs up a vigorous shoot, which develops roots of its own, and becomes an independent plant when the connecting branch dies or is cut off. Such offshoots from the parent stem are called *stolons*.

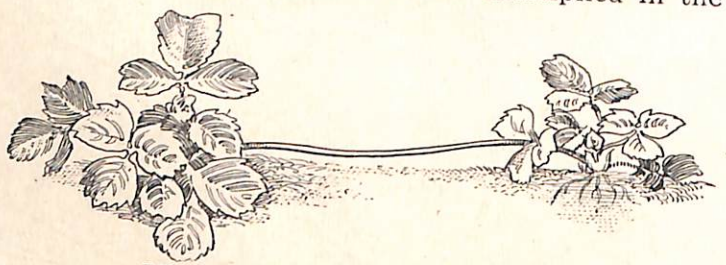


STOLON FROM A BERRY BUSH

Did you ever notice how the strawberry plant sends out long, running stems, which may take root every few inches? We say the strawberry multiplies by *runners*.

Place such stems as the geranium in a bottle, and leave long enough, and you will find that roots begin to form upon them, and new plants will grow in your bottle.

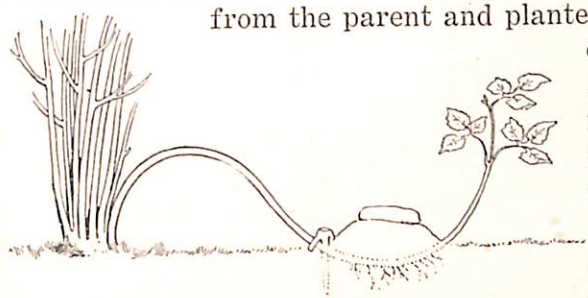
This habit that certain plants have of multiplying by developing new plants from buds, has been studied by the gardener and the farmer, and as a result plants are now multiplied in the five following ways: (1) by layering; (2) by cuttings; (3) by tubers; (4) by bulbs; (5) by budding and grafting.



RUNNER FROM A STRAWBERRY PLANT

Layering is one of the simplest ways of rearing plants. Without being cut off, one or more branches of a plant are bent down and covered, or the soil is piled up around them. Branches thus treated are called *layers*. The tips of the branches

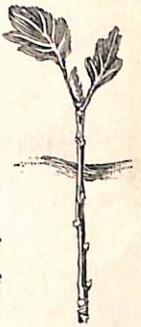
are always left uncovered. In a few weeks, roots will form near the buds on the covered parts of the stems. The stems can then be cut off below the roots, and the new plants can be removed from the parent and planted in another place. The currant, gooseberry, grape, and other plants may be propagated — that is, increased in number — in this way.



LAYERING OF BLACKBERRY SHOOT

In rearing plants by *cuttings*, a cutting, which is a portion of a stem having at least one healthy bud, is planted in the soil. Roots grow from the stem, or from the base of the bud, while the bud expands into a leafy stem. When buds appear on the cuttings, all but one are broken off, so that the full strength of the plant may be forced into the one bud. Cuttings are ready to be transplanted and potted as soon as two or three leaves have formed and the roots have well begun to develop.

Cuttings made during fall or winter or early spring are called *dormant cuttings*. The grape, the currant, the orange, and many shrubs are propagated from dormant cuttings. In cold climates, these dormant or sleeping buds are stored away in moist soil or sand until the following spring.



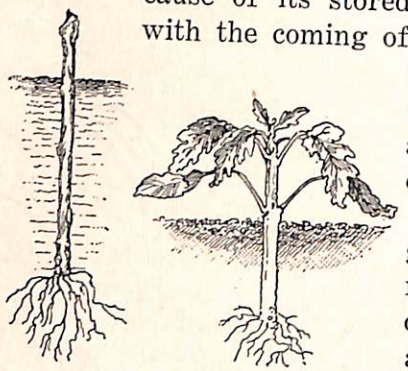
GERANIUM CUTTING

Green cuttings are made from a tender part of the plant, and each one has a leaf attached. This leaf is left on to prepare food for the growth of the roots. After the roots form upon the cuttings, the little plants are placed in small flower pots. Roses, geraniums, and many other plants are easily propagated by green cuttings.

The potato is reared by *cuttings of the tuber*, which, as we already know, is a modified stem. The "eyes" upon the potato

are buds, which grow into new plants. The tuber supplies food for the bud until it becomes an independent plant.

Lilies, hyacinths, tulips, and other plants are grown from *bulbs*. A bulb is a short underground stem, a thickened part of a plant, which is a storehouse for food. Roots grow from its lower surfaces; and above, it is covered with thick scales. Because of its stored food, the plant will grow rapidly with the coming of the early spring days; and anemones, snowdrops, daffodils, crocuses, and jonquils, also tulips, hyacinths, and narcissuses, are among our early spring beauties.

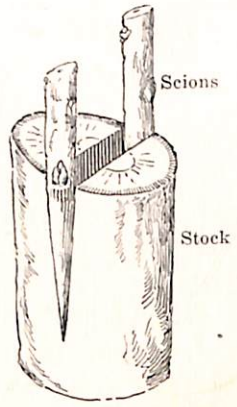


ROOTED GERANIUM CUTTINGS

These bulb plants should be grown in a sandy loam that gives ready drainage and does not receive too much sunlight. If bulbs are to be potted, prepare the potting soil of loam, leaf mold, and sand, in equal parts.

Plant the bulbs generally so that their tops just appear at the surface. Keep the pot for four or five weeks in the dark, to encourage the development of the roots. After this period of "root setting," warmth and water will cause the bulbs to flower. Chinese lily bulbs will flower luxuriantly, and bring much joy and fragrance into the schoolroom. They can be grown in open bowls filled with stones. Place the bulbs upon the stones so that their base barely touches the water in the bowl. Set aside in a cool, dark, airy place until the roots have had a chance to get a start. As the water evaporates, refill the bowl, keeping the water fresh and sweet. A piece of charcoal will help to keep the water pure. A little nitrate of soda or saltpeter dissolved in the water will hasten the growth of the plant. Bring the bowl into light and warmth, and you will enjoy the opening blossoms.

After the flowers die down, late in the spring, the bulbs should be lifted and put away in dry sand, as very often they can be used again in the fall.



GRAFTS IN PLACE

Rootstocks are another class of underground stems, growing horizontally under the surface of the soil, covered with scales, which are reduced forms of leaves. Mints and sedges grow from rootstocks.

Grafting is chiefly used to cause fruit trees to bear a better quality of fruit. If a farmer has a tree that bears poor apples, he can graft the buds of a choice fruit into the tree, and if his work succeeds, his tree will in time bear the choice apples.

The tree to be grafted over is called the *stock*, and the twigs to be grafted into the stock are called *scions*. The live parts of the bark in the stock and in the scion are bound together, and the wounded surfaces are then covered with grafting wax.

GRAFTS PROTECTED BY WAX

Questions

1. What is the difference between an underground stem and a root?
2. What is the difference between a sucker and a stolon?
3. Name three kinds of underground stems.
4. What are runners?
5. What is a cutting? A layer?
6. In what five ways are plants propagated without seeds?
7. What is a dormant cutting?
8. What is a tuber? A bulb?
9. Explain how to plant and care for bulbs.
10. When is grafting chiefly of value?
11. Explain the wonderful grafting described in Rom. 11: 13-24.

Requirements

1. Place in water, cuttings of any kind that root readily, and at intervals of two or three days sketch the roots that develop.
2. Secure bulbs, pot them, and watch the development of the plants.
3. Examine a hill of potatoes.
4. Look in the garden for *runners, stolons,* and *suckers.*

Note Book Requirements

1. Draw and describe a layer, a cutting, a bulb, a tuber, and a rootstock.
2. Draw and describe *endogenous* and *exogenous* stems. (See "Kinds of Stems," Book 2, page 152.)

Lesson L

Crops and Weeds

Cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life; thorns also and thistles shall it bring forth to thee; and thou shalt eat the herb of the field; in the sweat of thy face shalt thou eat bread, till thou return unto the ground. Gen. 3: 17-19.

Under the curse of sin, all nature witnesses to man of the character and results of rebellion against God. Instead of the happy labor appointed them in their Eden garden, the man and woman to whom God had given that beautiful home went forth to a world cursed with thistles and thorns. And yet, did you know that the weeds, the thistles, and the thorns were given, and still are needed, as "a part of God's great plan for recovery from the ruin and degradation of sin"? This curse was given in love.

Weeds may be said to be plants out of place, and truly they are not in the right place when in our gardens. They use up the moisture that the growing plants need. They feed from the same

THE WEEDERS

soil, and their stems reach up for the same sunlight. If a good crop is expected from the farm, or if a fair chance is to be given the flowers and vegetables of the garden, the weeds must be destroyed.

We have already learned that keeping the surface of the land covered with a layer of crumbled soil tends to prevent evaporation. Fortunately, the same treatment tends to keep weeds from growing. This is, then, a twofold reason for keeping the surface soil well cultivated, especially in the warm weather.

Some weeds grow up, blossom, ripen their seeds, and perish, all in one season. These are called *annual* weeds. Weeds of this class are usually easy to destroy; for if we pull them up, or cut them off at the surface or a little below it, they do not often grow again. Many of the most common weeds are annuals. They should be cut off or pulled out before they form their seeds, for they usually seed very freely.

Weeds that grow in part during one season, and live through winter, to blossom, ripen their seed, and die the next season, are

called *biennial* weeds. These are sometimes difficult to destroy the first season of their growth; but the second season, if cut off just before blooming, they soon die without yielding seed.

Weeds that continue to yield and bear seed from year to year are called *perennial* weeds. Some plants of this class multiply from buds on underground parts as well as by seeds. The morning-glory, the sow thistle, and the quack grass are weeds of this class. Perennial weeds are the hardest of all to destroy.

We have learned that the food that nourishes the roots of plants is formed in the leaves. Therefore if we prevent the leaves from growing, after a time the roots will starve. This is the surest way of killing perennial weeds, although it is sometimes hard to carry out.

Crops that require cultivation, such as corn, potatoes, and beets, help to rid the land of weeds. The careful cultivation of the crops will in time greatly reduce the growth of weeds; and the more thorough we are in keeping them out of the land, the easier the work becomes. But the warfare must be constant, and above all we must remember that weeds spread chiefly through their seeds. Hence no effort should be spared in destroying the plant before it produces seed.

When pulling the weeds in our gardens, we may think of the work that must be done in ridding our lives of wrong habits. Just as the weeds and briers steal strength from the garden soil, so wrong habits steal strength from the character. As every weed that grows pumps water out of the soil, so every wrong habit is at work robbing us of that "well of water" which may be ours, and which springs up to everlasting life. If we do not pull up the weeds, they will starve or choke out the good plants.

In the parable of the sower, Jesus illustrated this truth when He said, "And these are they which are sown among thorns; such as hear the word, and the cares of this world, and the deceitfulness of riches, and the lusts [desires] of other things entering in, *choke the word*, and it becometh unfruitful." This

shows that if we do not weed out the wrong habits in our lives, the seed of the Word will be choked out.

Wrong habits, like weeds, are very tenacious of life, and the only way to get rid of their baleful influence is to give them up. They are like weeds in another way — they bear much seed, which produces an abundant crop of other bad habits, and so "one sinner destroyeth much good." One bad boy or girl in the home or school is like an evil weed, sowing discord and wickedness all about.

We must deal with wrong habits as with weeds. Each must watch for the first growth of sin in the garden of the heart, and uproot the first tendency to wrong. The longer the wicked habits grow, the more difficult it will be to banish them from the garden of the heart. Make determined, persistent efforts to keep evil habits out of the life.

Remember that we may have the help of an all-wise Gardener in the work of heart culture.

Questions

1. Contrast labor in Eden and after sin entered.
2. In what way are the weeds a part of God's plan since the fall?
3. Why is a weed out of place in a garden?
4. Give two reasons for keeping the soil well cultivated.
5. How are weeds classified with reference to duration?
6. How are weeds scattered broadcast?
7. Give successful methods of ridding the land of weeds.
8. What weeds do you find in your garden?
9. What lessons have you learned from the weeds?
10. What kind of gardener or farmer allows the weeds to grow? Prov. 24: 30-34.

Requirement

Make a collection of the various weeds of your neighborhood, and mount them on paper or cardboard for reference. Learn what you can about their habits and the easiest means of controlling them. In your study, select representative specimens, and dig them up, leaving roots and top intact, and if possible, get them while in blossom. Spread them out carefully between old

newspapers. Weight them down, changing the papers often until the plants are dry. When dry, mount them. Label them with date and place gathered, also state any facts that you have learned from observation of the specimens.

Lesson LI

The Necessity of Flowers

For, lo, the winter is past, the rain is over and gone; the flowers appear on the earth. Song of Solomon 2: 11, 12.

The flowers are among the most beautiful and fragrant of natural objects. They delight us with their colors, their perfume, their delicacy, and their graceful forms. It matters not where we find them, they never fail to attract and please. They come to us each springtime bright with promise and radiant with hope.

It is by means of their flowers that year by year the plants are able to form the fruits and seeds that we prize so much for food. Did you ever think about it? There is no part of a plant so transitory, and yet there is no part so necessary to the important work assigned the plant.

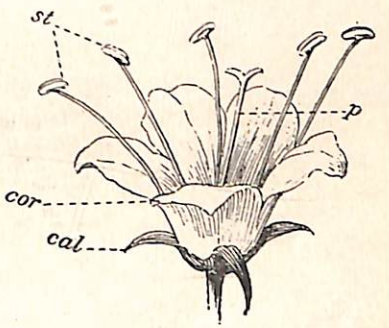
In plants that live through the winter, the flowers are commonly formed in the buds the season before they expand. If you will gather the large winter buds of the horse-chestnut, or buckeye, and cut them open, you will find the next season's blossoms curled up within. If you will make a collection of twigs from the orchard and garden, and put them in water in a warm, sunny window, you will enjoy watching the buds expand into leaves and flowers.

Upon most of your twigs, the *flower buds* are first to open. Notice the leaflike parts of the *calyx* loosen. Watch the *corolla* unfold. Look within, and examine the *pollen-bearing anthers.* If we are looking at a *perfect* flower, we shall find the *stigma*

at the top of the seed case, or *ovary,* which is at the center of the flower. The ovary is always found to contain a small, egg-shaped part called the *ovule,* which may later become the seed.

Go into the garden and find a cherry blossom. Closely examine its parts. We shall find the *sepals* united nearly to the top in the *calyx* of the blossom. You have already been told that the cherry belongs to the rose family, and you will find five *petals* forming the *corolla* of the blossom.

Inside the corolla of the cherry blossom is a group of slender *stamens.* Each stamen consists of three parts: the *filament,* or slender portion attached to the calyx below; the *anther,* or swollen portion at the top; and the *pollen,* a dustlike substance found on or within the anther.



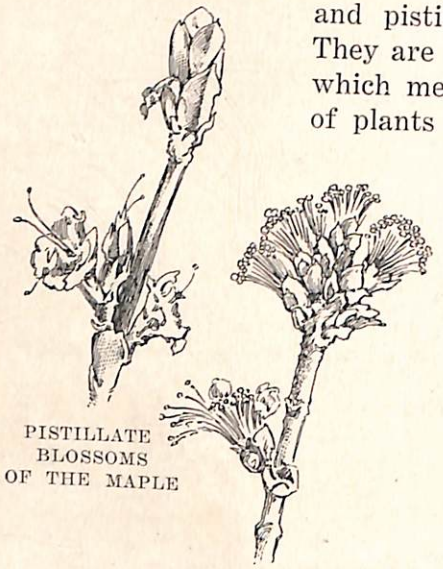
ORGANS OF THE FLOWER
cal — Calyx st — Stamens
cor — Corolla p — Pistil

The *pistil* is the columnlike body in the center of the flower. It also consists of three parts: the *stigma,* or enlarged top of the pistil; the *ovary,* or egg-shaped base; and the *style,* which is the slender part connecting the stigma and the ovary.

In the cherry ovary we find but one ovule. When this ovule is fertilized by the pollen from the stamen, it will develop into the *cherry pit* with which you are all familiar. The pollen grains fall upon the stigma. Each tiny grain puts out a long tube, which runs down through the style into the ovary, where it comes in contact with the ovule. The pollen grain must be from the same flower as the pistil, or from another flower of the same kind of plant. If no such pollen grain alights on the stigma, the ovule does not become a seed, but in time perishes. The alighting of the pollen upon the stigma is called *pollination.*

Now you will understand why we call the stamens and the pistil the *essential organs* of a flower.

You will find that the flowers of some plants do not contain both stamens and pistils. Some of the flowers have stamens only, and are called *staminate;* others contain pistils only, and are called *pistillate.* Such flowers are *imperfect,* and the pollen that reaches the stigma of a pistillate flower must always come from another blossom. The castor-oil plant, Indian corn, the begonia, walnut, hickory, oak, chestnut, and others bear both staminate and pistillate flowers on the same plant. They are therefore called monœcious plants, which means that the flowers of each kind of plants are of one household.



PISTILLATE BLOSSOMS OF THE MAPLE

STAMINATE FLOWERS OF THE MAPLE

The willow, the poplar, the box elder, the cottonwood, the hop, and the maple all bear imperfect flowers. These and many others have on some of their plants staminate flowers only, and on others pistillate flowers only. The plants having pistillate flowers must be fertilized by the pollen from the plants bearing staminate flowers. Those that bear the staminate flowers only, never produce seeds. Such plants are dicœcious — of two households.

Some flowers depend upon insects to carry the pollen and place it on the right spot — that is, on the stigma; other plants depend on the wind. The corn has all its pollen in the tassel, from which it is carried by the wind to the silk, or long stigmas, of the ear. Pollen-bearing plants must be grown among seed-bearing plants in order to bring about fertilization.

Pollen is easily spoiled by dew or rain, and nearly every flower has some way of keeping its pollen dry. Can you find out some of these ways?

Experiment

Tie paper bags over certain buds before they open. If they blossom and make seeds, we know that they do not need the aid of wind or insects. Such fertilization is called *self-pollination.*

Questions

1. In what ways do flowers delight us?
2. Why do we have flowers? and what is their chief object?
3. Name the parts of a *perfect* flower.
4. Contrast perfect and imperfect flowers.
5. What are the essential organs of the flower?
6. What is the *ovary?* The *ovule?*
7. What is pollination?
8. Contrast staminate and pistillate flowers. Find examples of each.
9. What is a monœcious plant? Dicœcious? Give examples.
10. Does rain ever spoil the fruit crop by preventing pollination?
11. In what interesting ways do flowers of your acquaintance protect their pollen?
12. How is pollen carried from one flower to another?
13. Examine pollen grains under a microscope, and describe their appearance.

Note Book Requirement

Collect and draw a raceme, a corymb, an umbel, a spike, and a catkin. (See lessons 52 to 54 of Book 2.)

Lesson LII

How Plants Can Be Improved

And the Lord God took the man, and put him into the garden of Eden to dress it and to keep it. Gen. 2: 15.

In the beautiful garden that Adam was privileged "to dress" and "to keep," there was no plant disease. There were no insects or other garden pests. There were no useless weeds to choke and starve the plants of the garden. There "the earth brought forth grass, and herb yielding seed after his kind, and

A PRIZE CORNSTALK

the tree yielding fruit, whose seed was in itself, after his kind: and God saw that it was good."

It is wonderful how every living thing is dependent upon every other living thing. Just as truly as we need the help of plants, so truly do the plants need our help; and especially is this true since the results of disobedience are more and more manifest in the growing vegetable life upon which man is so dependent.

The foes of plant life are numerous indeed. More and more has it become necessary for man to study how "to dress" and "to keep" the plants; for unless help and care are given them, they fail to supply man's need.

The student of vegetable life will become a student of the animal life that interferes with plant culture. Slugs and snails must be trapped and destroyed; field mice and gophers must be poisoned; and ways of checking the ravages of insects and d i s e a s e must be searched out. Crops must be carefully cultivated, as we have already learned.

In order that all this care may not be wasted, it is very necessary that, first of all, the *seed selected for planting* be only the choicest.

The offspring of a plant is usually more nearly like the parent plant than like any other. If we select always the seed of only those plants that excel, the crop will always be "after his kind."

We have already studied those words of Holy Writ, "Whatsoever a man soweth, that shall he also reap."

In selecting seeds, the whole plant should be considered. If we sow the seeds of a plant showing certain desirable qualities, we shall have, as a result, a crop of such plants. From these plants, we may make a new selection, planting the seeds of the superior ones only. And thus we may continue year after year, until we shall have developed a variety having some special advantage. By *careful selection* and *proper cultivation* combined, crops improve from year to year.

Great progress has been made, at certain experiment stations, in developing valuable varieties of wheat, oats, and corn. The yield in each case has been greatly increased also.

In Wisconsin and other states, where special stress has been put upon corn improvement, it has been found possible to double the yield. The farmers of the state are now able to secure seed properly selected, cured, and tested, and we have several standard varieties of corn for Wisconsin alone.

There are boys who have been encouraged to raise corn, under the direction of the United States government, and various prizes have been offered for the most successful. One boy secured the amazing yield of 228 bushels to the acre. Another boy, eleven years old, and small for his age, produced 102 bushels to the acre.

Distinct breeds of plants are sometimes secured by *cross-fertilization.* This occurs when the pollen of one variety of plant fertilizes the ovules of another variety. Cross-fertilization is often brought about by the wind or by insects. It is sometimes brought about by the intention of the gardener.

Luther Burbank is an American horticulturist who in this way has originated many new varieties of fruits, flowers, and

vegetables. Other growers also have done much in the same line.

Questions

1. Name and classify the foes of plant life with which you are familiar.
2. What is the most important function of the plant?
3. In what way are plants dependent upon our care?
4. What importance is attached to the selection of seed for a crop?
5. Explain how a superior variety of plant is often developed.
6. Explain cross-fertilization. Give familiar examples.
7. What spiritual truth is explained by this lesson? Gal. 6: 7-9.

Note Book Requirement

Review lessons 49 and 50 in Book 2, and upon page 49 of Note Book make the following drawings: (1) a simple leaf and its parts; (2) a compound leaf; (3) cordate, rotund, oval, oblong, ovate, lanceolate, and obcordate leaf shapes; and (4) the following leaf margins: entire, dentate, serrate, crenate, and cleft.

Lesson LIII

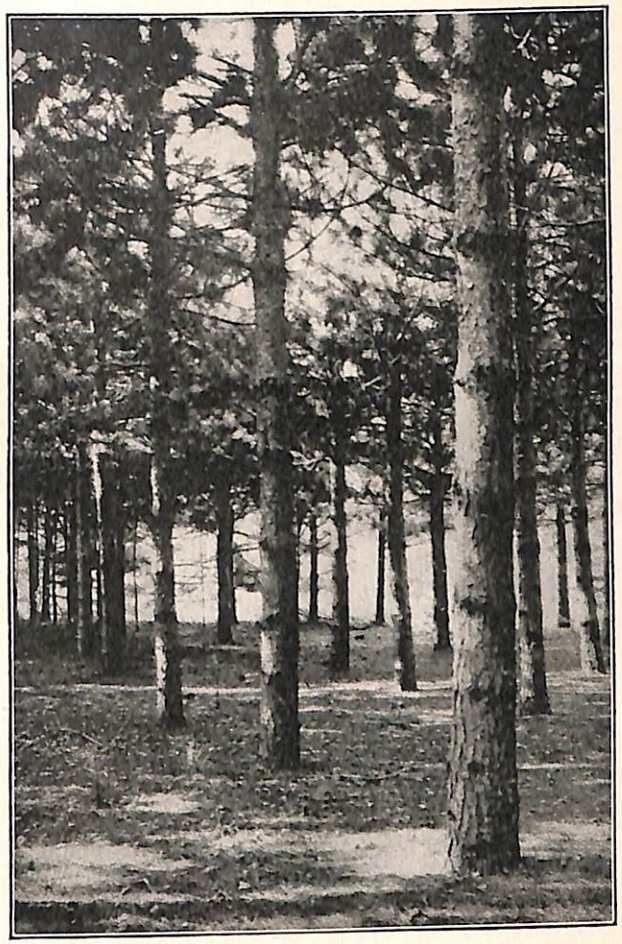
In the Forest

And out of the ground made the Lord God to grow every tree. Gen. 2: 9.

Each continent has extensive forests. In Europe the largest forests are in Russia, Germany, Austria, and Switzerland. In Asia the densest forests are found in India, on the southern slopes of the Himalayas. Large forests exist also in Siam and Burma, in the northern part of China, and in Siberia. South America contains the most extensive forests in the world. These are found in the basin of the Amazon. In the basin of the Kongo in Africa is another forest of almost equal extent. There are also vast forests in North America.

The kind of trees most abundant in any particular forest depends upon the temperature, the amount of moisture, and the nature of the soil.

In the forests of the cold temperate climates, cone-bearing trees, such as pine, spruce, and hemlock, are the most numerous. Beech, maple, and other hard woods grow in the forests of the warmer climates.



GOD'S FIRST TEMPLES

In the warm temperate climates, we find the oak; while in the forests of tropical regions grow various species of palm, and mingling with these are found mahogany, teak, and other cabinet woods, also climbing plants of gigantic size.

Forests, both tropical and temperate, contribute an immense share to man's welfare and progress. The manifold uses of woods, gums, resins, juices, roots, leaves, flowers, and fruits, are familiar facts to us. In the Temperate Zones, the chief uses of the forests

are the wood for lumber and the bark for tanning. A great value of trees consists in their influence upon the climate of the open country in or near the regions in which they are located.

The thick matting of dead leaves and leaf mold, and the spongy roots of the forest trees, prevent rapid evaporation of rainfall, and enable the water that the ground receives from rain and melting snow to flow out gradually through springs and rivulets. Where there is no forest to hold it back, as the rain falls and the snow melts they run off the bare soil, flooding the lowlands, and escaping to the ocean. Then the streams cease to flow, the land dries out, and the crops fail. Freshets are common along all streams from whose sources the forests have been removed. The heavy downpour of rain tears away masses of soil, and washes away the rich humus of the forest floor.

BAMBOO FOREST IN CHINA

We have already learned that the roots of trees are continually taking up water from the soil and passing it back into the air in the form of vapor. Hence the vast area of forest leafage tends to increase atmospheric moisture. In all these ways the forests are of untold blessing.

Unfortunately, the importance of preserving the forests has not always been borne in mind. In some regions where timber was once very abundant indeed, and there was thought to be

but little use for it, the most wasteful methods of disposing of it have been adopted, and large forests have been entirely cleared away.

In the effort to save the forests from wholesale destruction, men of science have become interested in the study and care of forests, and measures are now taken to preserve certain forest areas under government ownership. The Bureau of Forestry in the United States has undertaken work along the following lines: caring for forest reserves, preventing forest fires, reforming the present methods of lumbering, planting new trees and protecting young growth in the forests, and assisting private owners in caring for their forests and woodlands.

PREPARING FORESTRY EXHIBIT

Lands either wholly or partly covered with forests, when set aside by the government as public lands, are known as national forest reserves. Among those in the United States is the noted Yellowstone Forest Reserve. The forest reserves are chiefly located around the headwaters of

great rivers, and are designed to contribute to the greatest good of all the people. Lumbering and grazing are allowed on these reserves, but always under the direction of the agents of the Bureau of Forestry.

One of the most important works carried on by this organization is the prevention of forest fires. It is estimated that since the settlement of the United States, more timber has been destroyed by fire than by the ax, and the annual loss by forest fires exceeds $50,000,000. Many of these fires could be prevented.

Experiments

1. Get an acorn, and place it in the neck of a bottle, the same way up as it sits in its cup. Keep the bottle full of water, and watch the small oak begin to grow. Find seeds of different forest trees to plant, in order that you may study the growth of the seedlings.

2. Take an equal amount of leaf mold from the forest, and sandy loam from the field. Be sure that the samples are thoroughly dry. We know that dry vegetable matter burns readily. Place each sample on a separate tin, and heat red-hot over a gas flame or a bed of coals in the furnace. Which leaves behind the most ashes? Put the burned samples away in separate dry bottles of similar size and shape for the school collection. Compare as to color and composition.

Questions

1. Locate the forest areas of the world.
2. What three things determine the forest growth of a region?
3. Describe the forests of the tropics.
4. Enumerate the uses of the forest.
5. Discuss their greatest value.
6. What are forest reserves?
7. What work is carried on by the Bureau of Forestry of the United States?

Note Book Requirements

1. Upon page 50 of Note Book, name leaves of your acquaintance having shapes and leaf margins similar to those upon the page.
2. Describe the "curious leaf forms" pictured on page 51.

A Forest Hymn

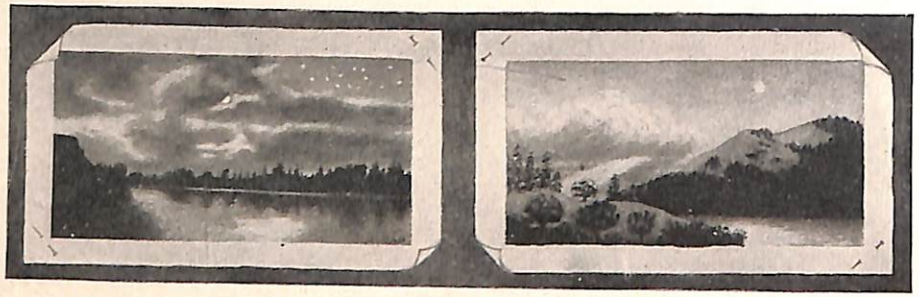
The groves were God's first temples. Ere man learned
To hew the shaft, and lay the architrave,
And spread the roof above them,— ere he framed
The lofty vault, to gather and roll back
The sound of anthems; in the darkling wood,
Amidst the cool and silence, he knelt down,
And offered to the Mightiest solemn thanks
And supplication. . . . Ah, why
Should we, in the world's riper years, neglect
God's ancient sanctuaries, and adore
Only among the crowd, and under roofs
That our frail hands have raised?
. . . Be it ours to meditate,
In these calm shades, Thy milder majesty,
And to the beautiful order of Thy works
Learn to conform the order of our lives.

— *William Cullen Bryant.*

CHAPTER VII

SUN, MOON, AND STARS

(Scripture Basis, Gen. 1:14-19)



"And God said, Let there be lights in the firmament."

Lesson LIV

The Celestial Sphere

There are also celestial bodies, and bodies terrestrial; but the glory of the celestial is one, and the glory of the terrestrial is another. 1 Cor. 15: 40.

The earth and the things upon it constitute the terrestrial sphere; and the sun moon and stars are bodies in the celestial sphere.

When we look up from the earth, the stars seem to be set in a blue vault, or dome, which we call the *sky*. The sky is not a substance, but the blue rays of light are reflected by the atmosphere through which we look. The dome seems to be highest directly overhead, and to curve down on every side and rest on the earth. One living on the opposite side of the globe sees the same kind of dome, or hemisphere; and as these two half spheres come together about the earth, we have a great globe, or sphere called by astronomers the *celestial sphere*.

How large the celestial sphere is, no one knows. The stars, which appear like so many golden spike heads nailed to the inside wall of the sky, all seem to be the same distance from us. But science proves this to be untrue. Sometimes two or more stars are in the same line of observation, and they then appear as one star.

The celestial sphere has a North and a South Pole, as our earth has. If the north end of the earth's axis were extended out far enough to reach the stars, it would almost touch our North Star, called *Polaris*. If the south end of the earth's axis were likewise extended to the sky, it would mark the place of the celestial South Pole; but there is no star to mark its position. To one standing at the North Pole of the earth, the North Star would appear directly overhead.

Having located the poles of the celestial sphere, we will next proceed to find the celestial Equator. If the earth's Equator were extended outward all around the earth until it would touch the sky, the great circle made by their intersection would mark the position of the celestial Equator. If one standing on the earth's Equator with paint pot and paint brush in hand, had an arm long enough to reach the sky, he could paint the celestial Equator while the earth made one rotation. This Equator passes through some of the stars, the brightest star near it being *Regulus*, in the constellation Leo, the star that forms the end of the handle of the Sickle. The celestial Equator also passes through the bands (belt) of Orion.

Now that we have found the celestial poles and the celestial Equator, we can see plainly that imaginary lines drawn around the celestial sphere through the celestial poles,— corresponding to our lines of longitude,— and lines drawn around the celestial sphere parallel to the celestial Equator,— corresponding to our lines of latitude,— will enable us to locate the stars and constellations of the celestial sphere in the same way that we locate cities and countries on the terrestrial sphere.

It is 360° around the celestial sphere, the same as around our earth; but we have no knowledge of its circumference in miles, for it includes the universe of God, which is infinite in extent.

The distance between the stars as they appear in the sky is measured in degrees on the circles that pass through them.

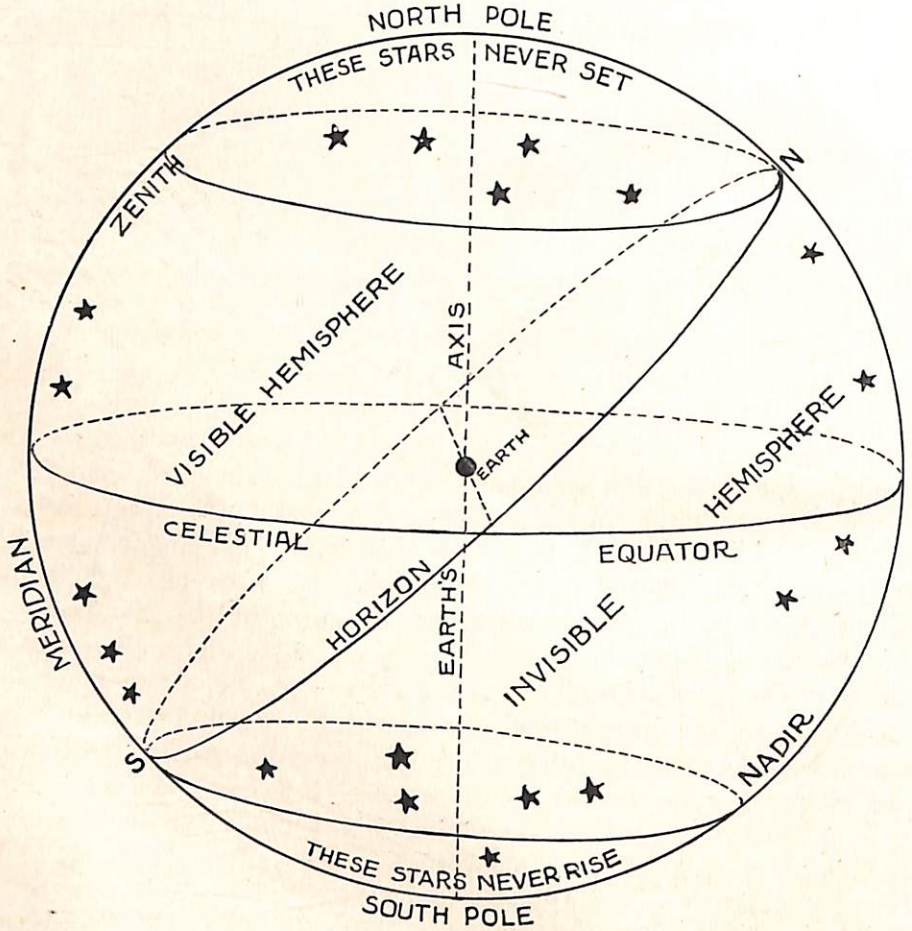


DIAGRAM OF CELESTIAL SPHERE

The celestial poles are 180° apart, and the celestial Equator is 90° from each celestial pole. In measuring on the celestial Equator, we start from the place called the vernal equinox,— the place where the sun crosses the celestial Equator March 21 of each year, at which time our springtime begins. The other measurement of the stars is made on the circles (meridians) running through the celestial poles, and the starting points of measurement are the celestial poles, depending on the hemisphere where the star or constellation is located.

There is another way of locating the heavenly bodies, which is of value only to local districts. It is much the same as that already described; but the point directly overhead corresponds to the celestial North Pole, and is called the *zenith*. The opposite point, corresponding to the celestial South Pole, is called the *nadir*. The circle where the sky seems to meet the earth is called the *horizon*. The stars are measured by the circles running through the zenith and the nadir, and on the horizon circle, which corresponds to the celestial Equator. The distance of a star from the zenith is called *zenith distance;* and its distance from the horizon, its *altitude*. But as one travels about, the zenith constantly changes; so also the nadir and the horizon.

How great is the wisdom and power of Him who made the celestial sphere, and who, as the Scriptures declare, "buildeth His spheres in the heaven"! How wonderful that the great God, "the high and lofty One that inhabiteth eternity, whose name is Holy," and who dwells "in the high and holy place," should promise to dwell with those who are of a humble and contrite spirit, to revive their hearts and cheer their souls in this world of sin! But it is even so; and let us be glad and thankful for it.

Questions

1. What is included in the terrestrial sphere? In the celestial sphere?
2. What is the size of the terrestrial sphere? The celestial sphere?

3. What wrong impression does one receive on looking at the sky and the stars?
4. Name the measuring lines and points of the celestial sphere, and compare the same with those of the terrestrial sphere.
5. How are stars and constellations most accurately located?
6. Describe the horizon system. Why is it not accurate?
7. What are the most valuable thoughts to be gained from the study of the celestial sphere?

Note Book Requirement

On page 63 write texts of Scripture that describe the appearance of the sky, and the relation of God to the universe He has created.

Thus

Lesson LV

Eclipses of the Sun and Moon

I form light, and create darkness: I make peace, and create evil: I the Lord do all these things. Isa. 45:7.

The Lord is the Creator and upholder of all things. He keeps all the worlds moving in their orderly march through the heavens.

We have in the Bible one example of His stopping the onward march of worlds. It was when Joshua led the armies of Israel against their enemies, and the day was not long enough to complete their overthrow.

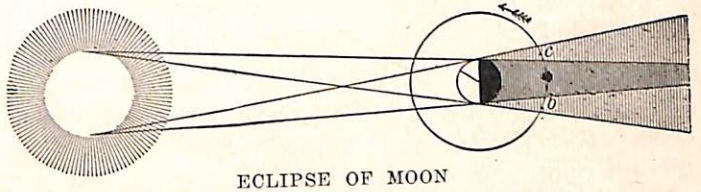
In the movements of the sun, moon, and stars, there are no collisions; but at times one of them passes in front of another, and in so doing obscures it. This occurrence is called an *eclipse.* When the entire face of a heavenly body is hidden, the eclipse is said to be *total.* In this lesson, we shall consider only the eclipses of the sun and moon.

The motions of heavenly bodies are so exact that the time of eclipses can be foretold with absolute accuracy as to the year,

the month, the day, the hour, the minute, and even the fraction of a second. The dates of eclipses of the sun and moon, for each year, are indicated in the household almanac. In the nautical almanac, used by navigators, the eclipses of all the planets in our solar system, and their moons, are indicated for ten years in advance. It is certainly marvelous that with figures man can find out the movements of heavenly bodies so far from this earth. He could not do it if the worlds were irregular in their movements.

When Christopher Columbus landed in America after one of his voyages, the Indians threatened to take his life. He knew there was to be an eclipse of the moon that night; and he told the chiefs that the Great Spirit was angry with them for planning to kill him, and that He would show His anger by darkening the moon at a certain hour that night. They waited to see if it would come to pass as Columbus had said. It did, and he was saved, and they looked on him as a god. Do you think Columbus was afraid the eclipse would not take place? — No; he knew that God would not lie in His works any more than in His word.

Let us now consider what causes eclipses of the sun and moon, and when they occur.

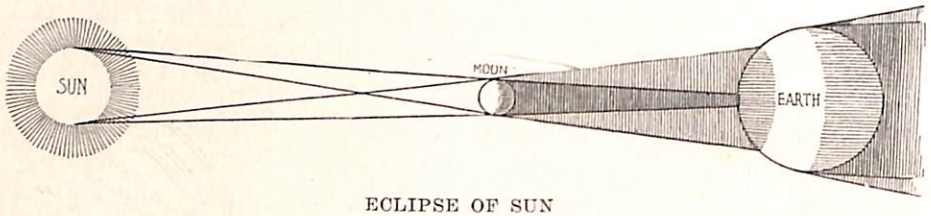


ECLIPSE OF MOON

1. *Eclipse of the Moon.*— All the planets, and their moons, called *satellites,* shine by light reflected from the sun. All these heavenly bodies cast a shadow on the side away from the sun. During the night, we are in the shadow made by the earth. Whenever the moon passes into the shadow of the earth, we have an eclipse of the moon. When only a part of the moon enters the shadow, the eclipse is partial; but if the moon is entirely within the shadow, the eclipse is total.

It is very interesting to watch an eclipse of the moon. As it enters the shadow, we see one edge grow dim, and gradually disappear. The darkness spreads until the moon is entirely darkened. About an hour and twenty minutes is required for the moon to pass through the earth's shadow.

The moon is never eclipsed except when full, as that is the



ECLIPSE OF SUN

only time the earth is between the moon and the sun. An eclipse does not occur at every full-moon period, because only occasionally are the earth, the moon, and the sun in a straight line. The reasons for this you will learn when you take up the study of *astronomy,* the science that teaches us the laws of the stars.

2. *Eclipse of the Sun.*— This is caused by the moon coming into line between the earth and the sun. The shadow of the moon falls upon the earth; but it is not large enough to cover the whole earth, therefore only those people living where the shadow touches the earth see the eclipse. The moon is often so far from the earth that its shadow does not reach the earth. In this case, we have only part of the sun's disk covered; and when the moon appears in the center of it, the sun looks like a ring. This kind of eclipse is called *annular,* which means *ringlike.*

The duration of a total eclipse of the sun is short, and the partial eclipse is shorter than that of the moon, as the shadow of the moon is smaller than the shadow of the earth.

There have been periods of darkness upon the earth not caused by an eclipse of the sun. Darkness was one of the plagues of Egypt. Darkness was again on the earth for a space of three hours at the crucifixion of Christ. May 19, 1780 — only a little more than a century ago — is recorded in history as a "dark

day." The darkness on that day was not caused by an eclipse of the sun, for the moon was full the next night. Just how the darkness was caused, we do not know; but the Lord says, "I form the light, and create darkness." Christ and some of the prophets foretold this day, and it came at the appointed time. They spoke of it as a sign of the near return of Christ and the end of this world.

The day when Jesus comes will be a day of darkness. Says the prophet Joel, "The day of the Lord cometh, for it is nigh at hand; a day of darkness and of gloominess, a day of clouds and of thick darkness."

While we are young, let us heed the instruction of the wise man: "Remember now thy Creator in the days of thy youth, while the evil days come not; . . . while the sun, or the light, or the moon, or the stars, be not darkened." Then when that day of darkness comes, we can be joyful, and say, "Lo, this is our God; we have waited for Him, and He will save us: this is the Lord; we have waited for Him, we will be glad and rejoice in His salvation."

Questions

1. How are all the heavenly bodies kept in order in their march through the universe?
2. Can the Creator stop the worlds in their onward march? Joshua 10: 12-14.
3. What is an eclipse? How many kinds are there? and what are they called?
4. Describe an eclipse of the moon. How is it caused? When does it occur?
5. Describe an eclipse of the sun. How is it caused?
6. With what certainty can eclipses be foretold? Upon what does their certainty depend?
7. Mention different times when the earth has been darkened without an eclipse.
8. What dark day was foretold by Christ and the prophets? Of what was it to be a sign?
9. When will another dark day occur? Joel 2: 1, 2; Zeph. 1: 14, 15.

10. How will the wicked feel in that day? Rev. 6: 12-17. What will the righteous say? Isa. 25: 8, 9.

Lesson LVI

The Constellations of Heaven

The heavens declare the glory of God; and the firmament showeth His handiwork. Day unto day uttereth speech, and night unto night showeth knowledge. There is no speech nor language, where their voice is not heard. Ps. 19: 1-3.

While David guarded his flocks on the Judean hills, he loved to gaze on the stars at night. We can learn something of how he felt, from the utterances that came from his lips. "When I consider Thy heavens, the work of Thy fingers, the moon and the stars, which Thou hast ordained; what is man, that Thou art mindful of him? and the son of man, that Thou visitest him?" The littleness of man and the greatness of God were impressed upon his heart, and developed in his character the graces of humility and reverence.

Again David says of God, "He healeth the broken in heart, and bindeth up their wounds." Listen now to the proof he gives that God knows every wounded, broken heart, and will heal and bind up their wounds: "He telleth the number of the stars; He calleth them all by their names." The telescope reveals untold millions of stars. It is believed that a thousand million might be counted on the photographs. This is but a small fraction of the hosts of stars in the great universe of God; and yet He not only knows their whole number, but He also knows the name of each one. And He knows the name of each of His children who live on this earth, and gives special attention to each.

A mere knowledge of the names given to the stars and constellations, and their position in the heavens, is of little value compared with the knowledge which, received into the life, enables us to develop a character that will entitle us to the grand privilege of visiting the starry worlds we have gazed upon. This is to be the pleasure and privilege of those who are redeemed from the earth when Christ comes.

We have already learned the position of the principal circumpolar constellations,— Ursa Major, Ursa Minor, and Cassiopeia,— and the names of a few others,— Lyra, Corona, Leo, Orion, and the Pleiades. We have also learned the names of a few of the brightest stars,— Polaris, Vega, Arcturus, Sirius, and Regulus; and I hope you are able to point them out in the sky. You had better review these stars and constellations in lesson 67, Book 2, so that you will have them clearly in mind. You should improve your opportunities to view the stars on clear, moonless nights.

The apostle Paul said, "One star differeth from another star in glory." Astronomers find that stars differ not only in brightness, but also in the colors of their light. We have yellow, red, purple, green, and blue stars. In fact, all shades of color that we find in the beautiful flowers of earth, are displayed by these lovely flowers of the sky.

We classify the stars according to their brightness, called *magnitude*. The brightest are called first magnitude stars. Examples: Vega, Sirius, Arcturus, and Regulus. The six brightest stars of Ursa Major, and the four brightest of Cassiopeia, are of the second magnitude. The stars a degree fainter are of the third magnitude; and those yet fainter, the fourth. The faintest stars that can be easily seen are of the fifth magnitude, unless the sky is exceptionally clear and moonless, and the eyes are good. Stars of the sixth and even of the seventh magnitude may be seen under favorable conditions. The faintest to be seen or photographed by the most powerful telescopes are of the eighteenth magnitude or less; and every increase of power of the telescope brings to view stars never before seen.

Every one who has taken any notice of the heavens on a clear night, has seen the Galaxy, commonly called the "Milky

Way" because of its white appearance. When the telescope is pointed at the Milky Way, it is found to be composed of innumerable stars. In some portions, the stars are more numerous than in others, forming clusters so dense that it is impossible to count them.

Questions

1. What do the heavens declare?
2. What Bible character was a diligent student of the starry heavens? What did he learn from his study? How did this knowledge influence his life?
3. What is the most valuable knowledge to be gained in the study of the stars? To what privilege will this knowledge entitle the student?
4. Name and locate the constellations already studied. Name and locate the fixed stars of which you have learned.
5. Describe the star colorings and star magnitudes. Give examples of the first two magnitudes.
6. Describe the appearance of the Milky Way. Of what is it composed?

NOTE TO PUPIL.— The star maps in the Supplement will be of assistance in locating the constellations studied in this lesson. Be sure to study out the location of the most prominent constellations, so that you may always recognize them in the sky at night.

Lesson LVII

Starry Wonders

Which maketh Arcturus, Orion, and Pleiades, and the chambers of the south. Which doeth great things past finding out; yea, and wonders without number. Job 9: 9, 10.

In this lesson, we shall study some of the wonders of the starry heavens. Some of them we would never have known were it not for the aid of the telescope.

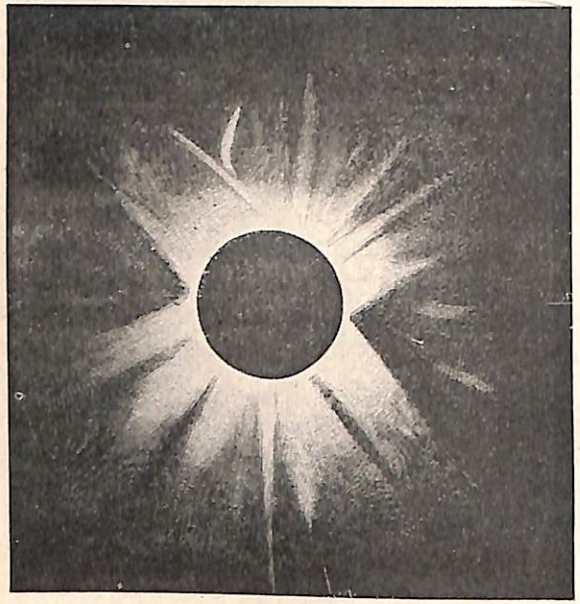
The Spirit of God, which wrought in our world at creation, did a wonderful work in the heavens. Job declares, "By His Spirit He hath garnished the heavens." The Spirit of God was the agency that decorated and beautified them.

Let us first consider the moon, the nearest of all the heavenly bodies, and learn how it appears through the telescope. By looking at this photograph of the moon, you will notice that its surface appears broken, ragged, and barren. Here and there are valleys, craters, and mountains. There are several large mountain chains and valleys. No atmosphere or water has been discovered, therefore it seems that the moon was not made for habitation, but to reflect light on the earth at night.

MOON SCENERY

The sun is so bright that in order to examine it a smoked glass must be placed next to the eyepiece of the telescope. Dark spots varying in size can be seen on the face of the sun. Occasionally they are large enough to be seen by the naked eye. What causes the appearing and disappearing spots, no one knows. When the sun is totally eclipsed, red cloudlike flames can be seen blazing out from it. A beautiful halo or effulgence also can be seen surrounding the sun during a total eclipse. This is called the *corona;* and the face of the sun is called the *photosphere.*

One question that has puzzled astronomers is this: How can the sun always keep up its supply of light and heat? Some have argued that it can not do this, and that sometime it will cool off, and all plant and animal life on the earth will perish. Others claim that the heat of the sun is kept up by small heavenly bodies passing into it, and serving as fuel to keep the fires of the sun burning. Some think this fuel supply will in time become exhausted, and the sun grow cold and dark.



CORONA OF SUN

Do we need to fear that the sun will fail, and that all earth life will be frozen to death? Notice what assurance the Lord gave David when he was troubled about the continuance of his kingdom: "Once have I sworn by My holiness that I will not lie unto David. His seed shall endure *forever,* and his throne as the sun before Me. It shall be established *forever* as the moon, and as a faithful witness in heaven."

We do not know just how the sun is made, nor how it will continue to be a never failing source of light and heat; but we do not need to know this in order to believe the promise of God. Children do not always know how their earthly father is going to keep his promises, but that does not hinder them from believing him. How much more should we believe our heavenly Father, who is so great and wise and good! Job said, "Great

things doeth He, which we can not comprehend." When David could not understand the mysterious working of God, he declared, "Neither do I exercise myself in great matters, or in things too high for me."

So far, we have studied two classes of stars,—the *fixed* stars, and the *wandering* stars, called *planets.* Now your attention is called to a third class, called *shooting* stars, so named because they shoot through the heavens, like a fire rocket at a display of fireworks. Another name given them is *meteors.*

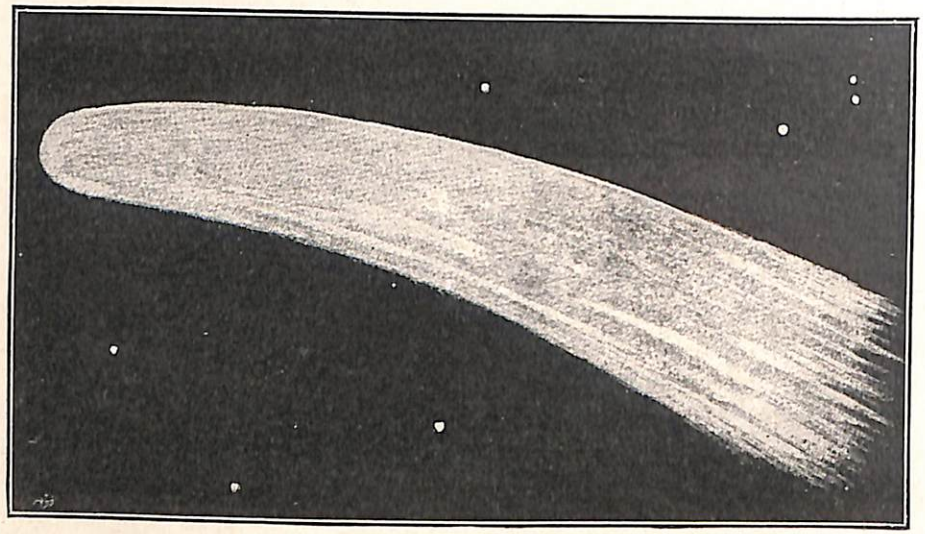
You remember that on our imaginary trip through the solar system described in Book 2, we passed through a swarm of about five hundred *asteroids,* which are small bodies revolving about the sun between Mars and Jupiter. Many of these can be seen with the telescope. But there are many very small bodies not visible in the strongest telescope. The earth encounters them in going around the sun. The friction produced by passing rapidly through the air, sets them on fire, and some of them are burned up before they reach the ground. Others are so large that they strike the earth before they are completely consumed. These are called *meteorites.* If examined soon after they fall, they will be found very hot, and perhaps partly melted. These meteorites are found in many museums. They consist largely of iron and stone.

Sometimes the earth gets into a swarm of these *meteoroids,* as they are called before they strike the air. We then have a meteoric shower. History records several of these showers; but the most brilliant occurred November 13, 1833, and came in accordance with the prophetic utterance of Christ when He said, "The sun shall be darkened, and the moon shall not give her light, and the stars of heaven shall fall." This is also one of the signs He gives that His second coming is near. November is a favorable time to observe the shooting stars, as are also the evenings about the ninth and tenth of August.

A heavenly visitor that attracts much attention, and that is looked upon with superstitious dread, is the *comet.* The first we

know, it is here. It may stay a few nights, and then is gone perhaps for many years. Some comets revolve around the sun in about three years, others require thousands of years for each revolution. Still others will never return their path leading them to other parts of the universe.

Brooks's comet, named after its discoverer, first appeared



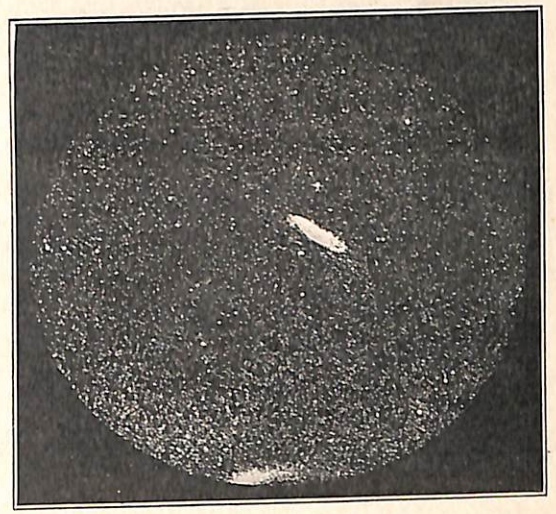
COMET

in 1889. It revolved in a period of seven years, returning in 1896 and in 1903, but not in 1910.

Halley's comet is one of the most remarkable in history. It was discovered by him in 1682. He learned that Kepler discovered a comet in 1607, seventy-five years before. He searched backward seventy-six years more, and found that history recorded the appearance of a comet in 1531. Seventy-five years earlier, 1456, the pope of Rome ordered prayers to be offered for protection against the Turks and the comet. Mr. Halley concluded the period of this comet was about seventy-five or seventy-six years. He then counted forward from 1682, and

predicted that the comet would appear again in 1759. It was seen March 1, 1759. Astronomers foretold its appearance in 1835, and it came into view about three months earlier than expected. Seventy-five years more brings the date to 1910; and some of us remember that Halley's comet was eagerly looked for then, and came on time.

Since people have learned that comets move according to Newton's law of universal gravitation, they have lost their dread of them to a large degree. The tails of comets do not contain poisonous gases that are destructive to life, as some people believe. No one knows what the composition of a comet is. It appears as a star surrounded by a cloud of what we might call star dust or vapor, but vapor so thin that it can not be recognized when the earth passes through the tail of a comet. There are small particles of dust floating in the air of your room. You can not see, taste, feel, or smell them; but when a sunbeam comes into the room, you can see them plainly. It may be the same with the comet dust, the sunlight only causing it to be visible.



NEBULA

Telescopic view of stars in the vicinity of the nebula Andromeda

There are several spots that appear as faint masses of soft light or thin clouds in the sky. Some of them can be seen with the naked eye in the Milky Way. Coma Berenices — Berenice's Hair — is another example. Many more of these faint, cloudlike masses, called *nebulæ,* can be seen with the telescope,

and are very beautiful and interesting objects to the astronomer. These masses are sometimes called *fire mist, fire vapor, star dust,* etc. Why are they so called, do you think? This is the reason: Some scientists have a theory of their own as to how our world and all the starry worlds came into existence. They believe that all was "fire mist" at first, and that as this mist cooled, it began to revolve, and finally got to going around so fast that rings were thrown off, and these became worlds by cooling and forming a crust. These scientists claim that these worlds are still very hot on the inside, but that some of them have cooled enough on the outside for vegetation and animal life to flourish on them. They teach that the sun is some of this "fire mist," and that it has thrown off the rings which formed our eight planets; and that these, while they were still hot, threw off rings which formed their moons.

It is declared that millions of years were required to make a world, because these "fire mists" took so long to form into balls and cool off. You see that some astronomers, like some geologists, will not admit that God created our world in six days and rested the seventh day. They also seem anxious to get rid of God's Sabbath day, which He made to help man to keep in memory His great work.

David tells us plainly how the Creator brought this world and the hosts of starry worlds into existence. Listen! "By the word of the Lord were the heavens made; and all the host of them by the breath of His mouth. . . . For He spake, and it was done; He commanded, and it stood fast." The worlds were spoken into existence. After speaking this world into being, God spent only six days of twenty-four hours each in preparing it to be a home for man, and gave him the next day — the seventh — for a Sabbath.

Some scientists tell us that the nebulous matter we see in the heavens is "fire dust," or "star dust," which is undergoing the process of making other worlds. But there is nothing in the Bible that hints at such an idea. Science also tells us that

this nebulous matter has no motion, and this is against the idea of world building.

What are astronomers finding as they study the nebulæ with telescopes of stronger power? — Just what they have learned in studying the Milky Way. The nebulous clouds of light disappear, and countless stars are seen instead. This innumerable host of starry worlds the Creator leads forth "by number; He calleth them all by names by the greatness of His might, for that He is strong in power; not one faileth."

NEBULA OF ORION, AS SEEN THROUGH A TELESCOPE

The Pleiades are a star cluster, plainly seen with the naked eye, while Coma Berenices is quite dim. There are several beautiful clusters visible only with the telescope. The most remarkable is the cluster of Hercules. This is composed of thousands of stars so close together that they can not easily be distinguished even with the most powerful telescope. When we remember that this is a cluster of suns, and that each sun has planets revolving about it the same as ours, what an immense universe the cluster of Hercules alone must be!

Notice some of the most interesting nebulæ that can be seen with the naked eye:—

The nebula of Andromeda is easily visible without a telescope. It appears like a small, hazy patch of light the shape of an ellipse. It is sometimes mistaken for a comet. Look at it with a small telescope or field glass.

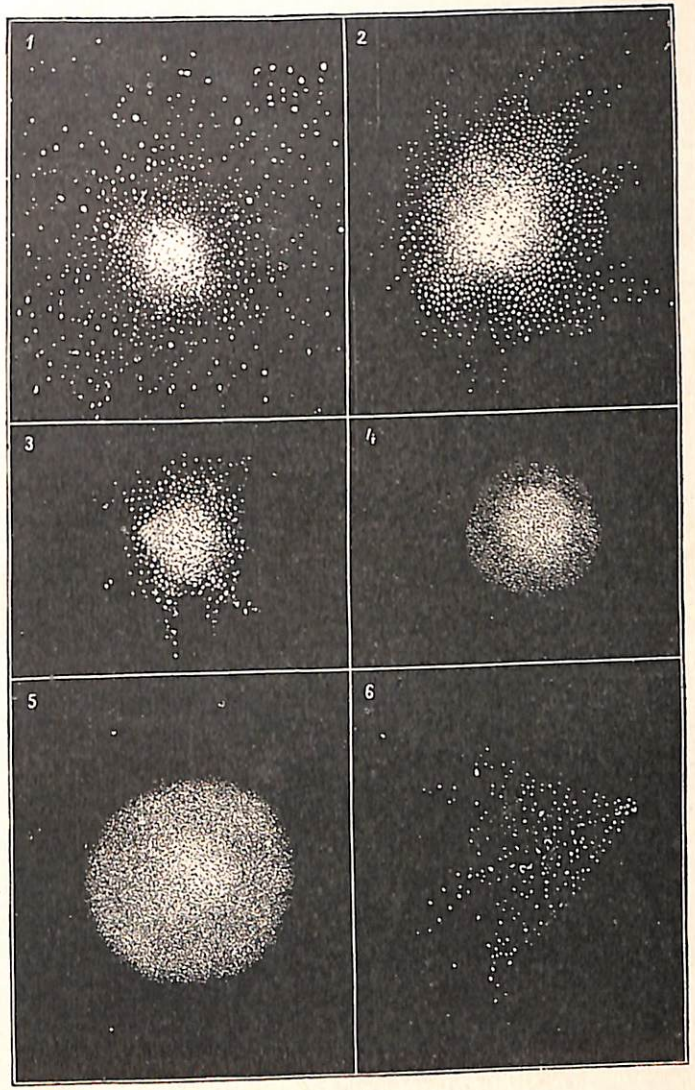
The nebula of Orion is the most noted of all. It appears like a star of the fourth magnitude with a hazy light about it. It is the middle one of the three dimmer stars in a row just below the three stars forming the "Yardstick." A good telescope shows a cavity, or open space, near one edge of the nebula. In this open space are a number of stars, four of which are brighter than the others, forming a sort of four-sided figure called the *Trapezium.* Astronomers tell us that a beautiful light seems to stream from an inner world down through what might be called this gateway to heaven. This would seem to be a fit opening through which the New Jerusalem may descend when transferred from heaven to become the capital of the new earth.

In Lyra is a ring-shaped nebula. Another nebula is called the *Dumb-bell.* You will find the constellations containing these star clusters and nebulæ indicated on the star maps.

We close this interesting study of the heavens by asking you to observe very closely two kinds of stars,— variable and double stars. Those that vary in brightness from time to time are called *variable.* Beta in Lyra is a variable star. Watch and compare it with the one next to it.

Algol in Perseus is a variable star, changing from second magnitude to fourth magnitude. Astronomers believe that one of its planets is nearly as large as Algol, and when it passes in front, shuts off part of the light.

Two stars that appear close together are called *double* stars. If they are actually close together, they are called *physically double;* but if they appear to be close together because nearly in a straight line, but do not belong to the same system, then they are called *optically double.* It has been found, by using



STAR CLUSTERS

the telescope, that a star which appears single to the naked eye, may be double, or triple, or quadruple, or sextuple.

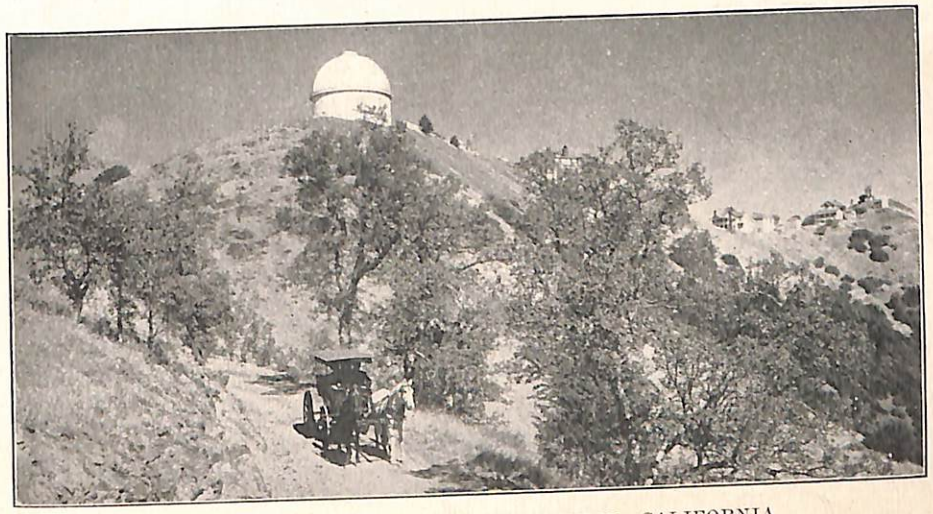
Several thousand double stars are now known; and in nearly all these instances, the stars are close together, and revolve about each other, forming what is called a binary system. Most of these double stars can be seen only with the telescope. Mizar in Ursa Major has a visible companion. Epsilon in Lyra is a visible double, which with the telescope resolves into four stars. Sirius and Procyon each has an invisible companion.

As we study these wonders, we must certainly be impressed with the words of Paul when he says, "Eye hath not seen, nor ear heard . . . the things which God hath prepared for them that love Him." If we are counted among the wise, we shall "shine as the brightness of the firmament; and they that turn many to righteousness as the stars forever and ever."

Questions

1. Can we fathom the mysteries of creation? Is there any limit to its wonders? Job 9:9, 10.
2. By whom were the heavens beautified? The earth? Job 26:13.
3. Describe the surface of the moon as revealed by the telescope. For what one purpose does it seem to have been made?
4. Describe the telescopic appearance of the sun. What purpose does the sun fulfill in the solar system?
5. What false ideas are set forth regarding the conservation of light and heat from the sun? How long does the Lord say the sun and moon shall endure? Ps. 89:34-37.
6. Is it necessary to understand all that God does, in order to believe what He says? How is the proper attitude toward God and His mysteries illustrated in human life?
7. How did Job and David regard the mysteries of God? Job 37:5; Ps. 131:1.
8. What are meteors, or shooting stars? Explain their shooting appearance. What is a meteorite? Of what is it composed?
9. What causes a meteoric shower? What shower was a fulfillment of Christ's prophecy in Matt. 24:29?
10. What is a comet? Describe its appearance and movements. Describe Halley's comet.

11. What is a nebula? What false theories have scientists advanced regarding the building of worlds?
12. In what respect does their theory contradict the Scriptures? In what way are the ideas of astronomers and those of geologists alike in the matter of world building? What does this theory attempt to destroy?
13. What is the plain teaching of the Bible concerning the creation of worlds? Ps. 33:6, 9; Ex. 20:8-11.
14. What are astronomers finding nebulous appearing matter to be?
15. Name several star clusters, and locate them. Which is the most remarkable?
16. Name and locate and describe some of the nebulæ. Which is most wonderful? Why?
17. What are variable stars? Give examples.
18. What are double stars? Name and describe the two classes. Give examples of physical doubles. What is a binary system?
19. What statement of Paul's do the starry wonders emphasize? 1 Cor. 2:9.
20. In what way do the stars represent the future life of the righteous? Dan. 12:3.



LICK OBSERVATORY, MOUNT HAMILTON, CALIFORNIA

CHAPTER VIII

WATER ANIMALS

(Scripture Basis, Gen. 1:20-23)

"And God said, Let the waters bring forth abundantly the moving creature that hath life."

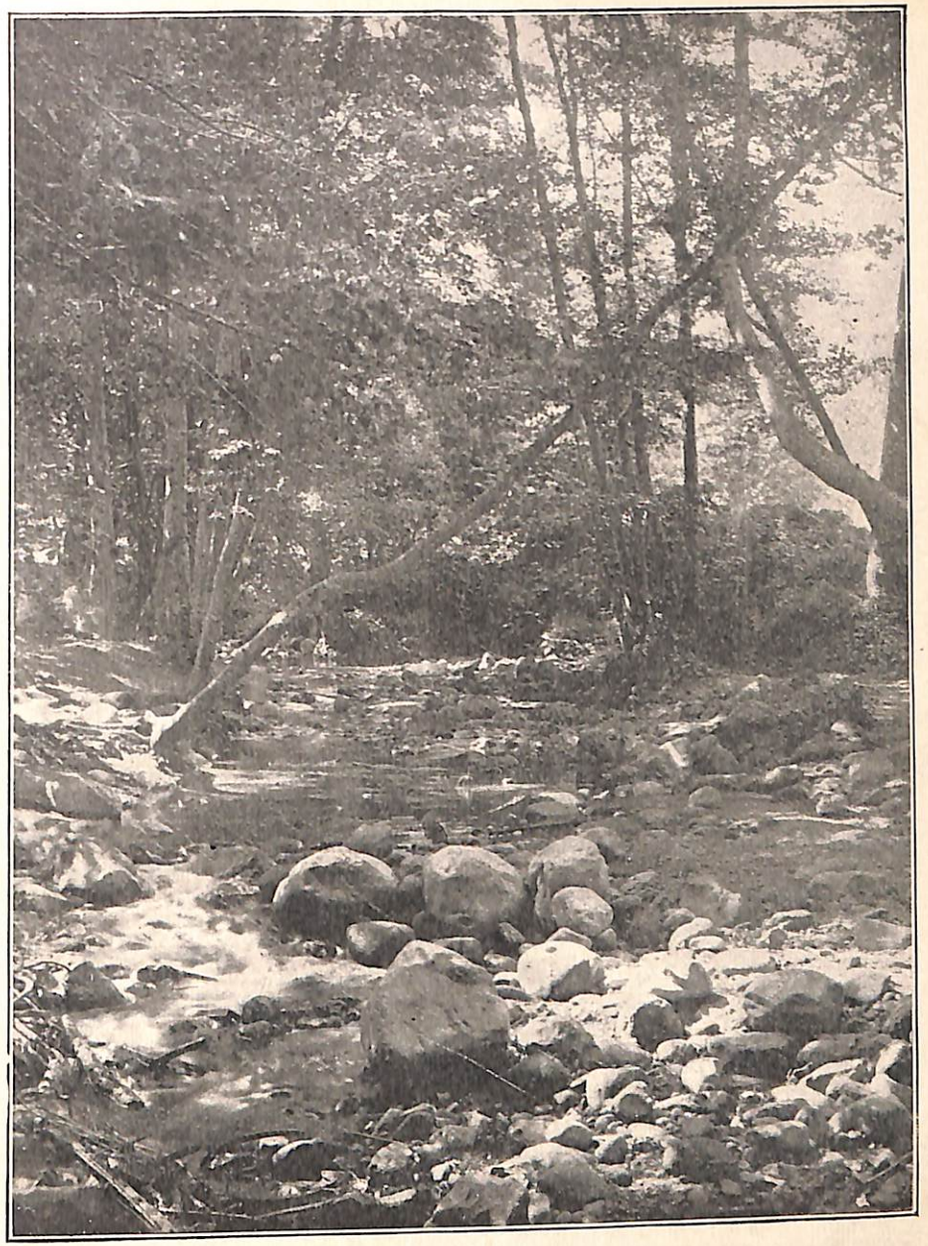
Lesson LVIII

The Simplest Creatures

Neither is there any creature that is not manifest in His sight: but all things are naked and opened unto the eyes of Him with whom we have to do. Heb. 4: 13.

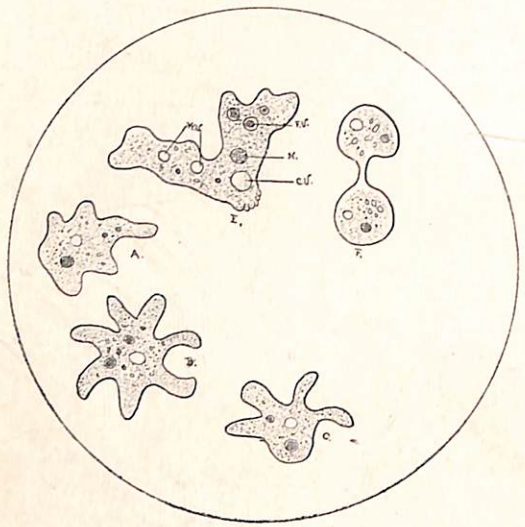
The Creator made each animal for a certain purpose, and gave it a definite place in the scale of being. They were perfect in the beginning, and did not need a series of changes to improve them.

If you gather stems of the water lily, or of some other aquatic plant, and put them into a jar of water for a few days, you will find, upon examining with a compound microscope the scum which rises to the top, that there are myriads of little living organisms in every drop of water.



IN CONGRESS SPRINGS PARK, CALIFORNIA

The simplest form that you will find is the naked amœba, or *proteus*. You will have to look carefully to see one, for they are nearly as transparent as the water. You will be better able to see it if you shut off the light a little with your hand. When you find the tiny creature, you will see a drop of jelly-like substance, with a somewhat dark, dense spot, called the *nucleus*, in the center. When first seen, an amœba may be almost any shape; but if you watch it closely, you will see it change both form and position. Suppose it is circular; in a few seconds it will thrust out little projections, called *pseudopodia*, or false feet. These aid it in securing food and in moving about from place to place. The amœba has the power to make a mouth at any point on its body. When it touches a morsel of food, it becomes about the shape of a kidney bean, with the food particle in the indentation. Soon it entirely surrounds its meal and takes it into the body, much as a drop of the white of an egg would flow around a grain of wheat. It uses that portion of the food which it needs to sustain life, and throws the remainder off at some other part of the body.



AMŒBAS (MAGNIFIED)

Very often you will find the little animal in the shape of a dumb-bell; and the strip of jelly connecting the two balls will continually grow smaller, until it completely divides, and the two balls form separate animals. The nucleus divides, also; and thus each new animal will have a spot on the inside. This

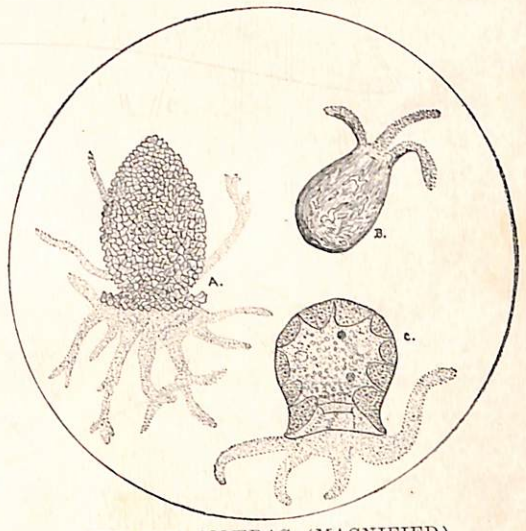
spot is the center of the life of the animal, and really comprises all of its vital organs.

Amœbas are not all like this specimen. Some build for themselves little coverings of fine sand, and take the shape of kettles, vases, etc. Others have a rather tough skin, and are disk-shaped. These all thrust out little feet, or pseudopodia, from beneath their covering, to aid them in moving around and in securing their food.

As we study these, the simplest of God's animal creation, we see that they are just as carefully made, with organs adapted to their necessities and surroundings, as are the more complex animals. This shows that the Creator is not unmindful of the little things; and it should teach us the lesson of faithfulness in small matters.

Questions

1. Name the simplest animal, and tell where it is found. How would you collect specimens?
2. Would you be likely to find more than one amœba in a drop of water? What does this little animal look like? (Break an egg on a plate. The yolk will represent the nucleus, and the white the transparent portion of the amœba. This is a very good representation.)
3. Has the amœba true feet? Does it walk about? How does it move? Has the amœba a mouth? How does it eat? (It lives mainly on small water plants, but it may often be seen to make a mouth and engulf other amœbas of smaller dimensions.)



SHELLED AMŒBAS (MAGNIFIED)

4. How does the amœba reproduce itself?
5. Is this method of reproduction a rapid one?

Note Book Requirement

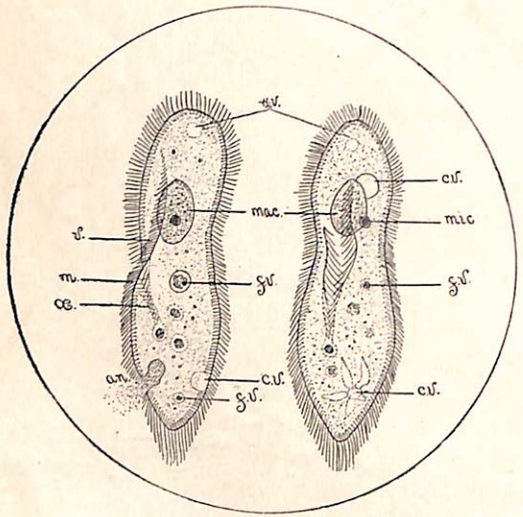
On page 71 describe the amœba. If you have a chance to view it through a compound microscope, make an outline sketch of its body each half minute.

Jule

Lesson LIX

Slipper-Shaped and Bell-Shaped Creatures

In the same drop of water in which you found the amœba, you doubtless noticed myriads of little slipper-shaped animals, not moving slowly from place to place, as does the amœba, but darting swiftly about, jostling their neighbors, and winding their way through the aquatic vegetation with scarcely a pause.



PARAMECIUMS (MAGNIFIED)

This minute creature is called the *paramecium,* and may be found in great numbers in every pool or jar of water in which there is decaying vegetation. The body substance of the animal is much the same as that of the amœba, but the shape and the general structure are quite different. Its quick motion is made by numerous tiny hairs, called *cilia,* which cover its body, and have a wavelike motion that propels

it about. This animal, unlike the amœba, has a definite mouth, which is located in the side of the body. When a particle of food comes near, it is taken into the mouth by aid of the little cilia, and thence through the esophagus into the body, where it forms a food ball. These food balls appear as spots, usually green or brown, in the body of the animal.

The paramecium has not only one nucleus, as has the amœba, but it has two,— one large bean-shaped center, and a small circular one near it. At each end of the animal, you will notice little circular markings somewhat resembling air bubbles. If you watch them carefully, you will see them take the shape of a star, contract, and then resume their former shape.

The slipper animal reproduces by division, as does the amœba. It takes the form of a figure 8, then divides transversely, the nucleus dividing with it.

This creature has many relatives in our ponds and pools, and all have either many cilia, or else single hairlike lashes, with which they move about, and which help them in securing food. The green scum common on stagnant pools is a close relative, and is composed of millions of little animals with a single lash. They multiply so rapidly that the surface of a pond may be completely covered in a short time. Hundreds of them can be counted in a single drop of water.

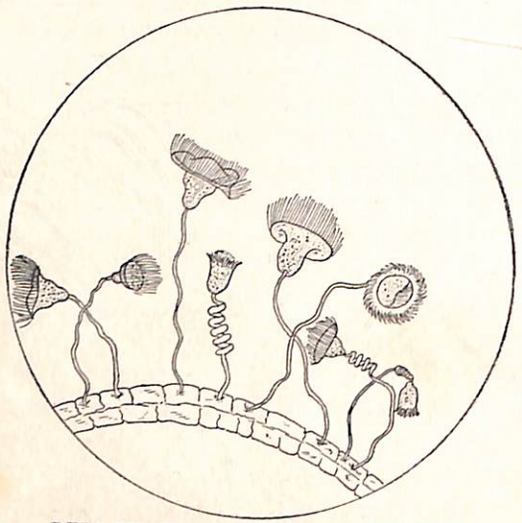
In your search for amœbas and parameciums, you are also likely to discover the bell animal, or *vorticella.* If you do, you will be delighted, I am sure. It is very simple in structure, like the amœba and the paramecium, being composed of a single cell. The body is bell-shaped or conical. Attached to its apex is a long, slender stalk; and when this is extended to full length, the little animal looks somewhat like a plant. But this stalk does not remain extended, and it has the power of contracting, and drawing the bell-shaped body down to the point of attachment.

This animal also is provided with cilia. They form a row around the rim of the bell, and keep up a continual wave

motion, thus aiding the tiny creature in the capture of its food by producing a powerful current centering in the mouth.

The bell animal also has two nuclei, one long and slender, the other small and circular. You will notice, too, that the food enters the body by a definite mouth.

The vorticella multiplies by division, and it presents a very interesting study at such times. The body divides vertically, but the stalk does not divide. Therefore, you see, at the completion of division there are two bells on one stalk. These remain thus for a time; but finally one breaks off, folds in the rim of its bell, acquires a belt of cilia around its middle portion, and attaches itself, after which it loses its belt of cilia, and takes the form of its parent.



BELL-SHAPED ANIMALS (MAGNIFIED)

The paramecium and the vorticella are herbivorous forms, feeding on minute plants, and especially on bacteria. The bell animal is not so common as the paramecium, but it can usually be found after a short search. One of its closest relatives is the *stentor*, which has somewhat the same form, but is slenderer and more trumpet-shaped. It is carnivorous in habit.

Questions

1. Describe the paramecium.
2. Compare its movements with those of the amœba.
3. What organs has this animal which aid it in swimming about?
4. Has it a definite mouth? Where is the mouth located? What does the paramecium eat?

5. Describe the vorticella.
6. Where are the cilia of this animal located?
7. How does the vorticella multiply? How does it eat?
8. When does the bell animal swim?
9. Are these little creatures vegetarians or meat eaters?
10. Name a carnivorous relative of the vorticella.

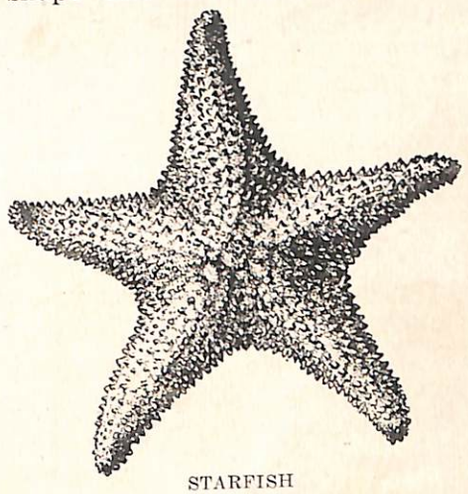
Note Book Requirement

On page 72 write a description of these microscopic animals.

Lesson LX

Star-Shaped Animals

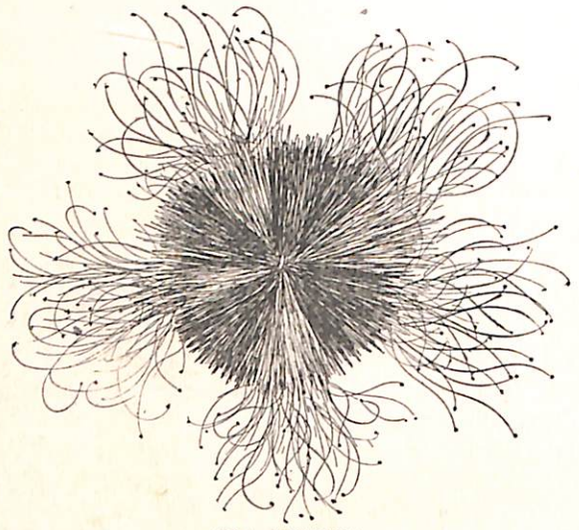
In your study of the water animals so far, you have found many creatures having queer shape and structure. Now we come to the study of an animal that looks like a star, and therefore is called the *starfish*. It is a rather ugly-looking object, its entire body being covered with short, stiff spines. The body has five raylike arms. At the end of each arm is a red spot supposed to be an eye. If this be true, the starfish has five eyes. Underneath each ray is a groove that extends to the central portion of the body, where the mouth is located. These grooves contain hundreds of feet, which the starfish uses in traveling about.



STARFISH

There are many species of starfish, differing in size, color, and shape. They have a large number of relatives, that live with

them in the sea. Some of the most common of these relatives are the sea urchin and the sea cucumber. The starfish uses its five rays, or arms, in capturing its food. It is a bitter enemy of the oyster. Several years ago, men who were engaged in the oyster trade, used to gather the starfish with tongs and dredges, and after breaking them up, would throw them back into the sea, hoping to get rid of the oyster destroyers thus. But in spite of all they did in this direction, the starfish seemed to increase and the oysters to decrease; and finally, after careful study and observation, it was found that each ray of the starfish developed into a new animal. Thus instead of destroying these mischievous creatures, the fishermen were multiplying them.



SEA URCHIN

A starfish creeps cautiously up to an oyster when its valves are open and its body fully extended, and places one or more rays between the valves, to prevent them from closing. Then it sucks the soft, fleshy portion of the oyster into its mouth. You see that starfish seem to think oysters are excellent food. And they may be such for starfish, but not for human beings. A close study of the oyster reveals the fact that it is a scavenger, occupying the same place in the water as does the hog on the land. Its business appears to be to clean up all dead and decaying matter it finds lying about.

The starfish's body is composed mainly of limestone; and when the animal dies its skeleton goes to the bottom of the

sea, along with those of myriads of other animals that secrete a similar bony material. A peculiarity about the skeleton of these creatures is that it is on the outside of the body. The starfish is a salt water resident, and is not found in our lakes and streams.

Questions

1. Why is the starfish so called?
2. What is the general appearance of the starfish? How many rays, or arms, has it?
3. What is the red spot at the end of each ray supposed to be?
4. Does the starfish have any feet? Where are they located?
5. In what respect do the many species of starfish differ? Name some of their near relatives.
6. What use does the starfish make of the five rays? Of what animal is it a bitter enemy?
7. What means were once taken to save oysters from destruction by starfish? How did this effort succeed?
8. Describe the manner in which the starfish captures the oyster.
9. What is the business of the oyster? What land animal does the same work?
10. What becomes of the skeleton of the starfish? What other animals have been mentioned that have their skeleton on the outside of the body?

Note Book Requirement

On pages 75 and 76 write a description of the starfish.

Lesson LXI

The Worm Family

Worms are creatures whose bodies are composed of ring-like segments, fitted end to end. This makes it possible for them to bend the body around in any direction. We shall consider one of the most common members of the worm family — the

earthworm. We study it in connection with the water animals, because it lives in the moist, damp earth.

The earthworm has several names, such as *angleworm* and *fishworm*. It is not a beautiful object, but it certainly ought to be appreciated for the great good it does. Earthworms are great soil stirrers, and are very beneficial to the farmer in pulverizing the soil. They are especially fond of living in rich, black soil, such as is usually chosen for a garden. You should obtain one or more of these worms, and study the body, noting how well it is adapted to the creature's manner of living. The moister the soil, the larger the worm grows. Many of them attain a length of eight or ten inches, and are about as large as a man's little finger.

EARTHWORM.

Count the ringlike segments of the body of an earthworm, and you will find that they number considerably more than one hundred. The body is not exactly round, but is somewhat rectangular in shape, being flattened on the bottom and the sides, and rounded on top.

How does the earthworm travel? Has it feet? If you think it has no feet, examine the under side of its body carefully with a microscope, and you will see that it has multitudes of them. You can also demonstrate this by drawing the animal backward across the fingers. The feet are arranged in double rows. Two of these are located on the under part of the worm, and one on each side, making four double rows in all. Each ring, or segment, of the worm has eight feet. How many feet does an angleworm have which has fifty segments?

This creature burrows in the soil by eating its way through it. Its body is well constructed for this purpose. In order to observe the habits of angleworms, study them at night, for it is then that they come out upon the surface of the ground. You will find them, also, just after a rain, crawling about on

the surface. Many persons have supposed that the angleworms come down with the rain; but this is not true.

Most of the worm family live in the water. A few, such as the tapeworm and the trichina, are parasitic, and live in the bodies of warm-blooded animals. The horsehair worm, the leech (commonly called *bloodsucker*), and the *rotifer*, or wheel worm, all live in the water. Most of the animals called *worms* are not worms, but are the larvæ of insects, and many develop into flies, butterflies, and moths. We seldom see a real worm. The most common one is described in this lesson.

Questions

1. What is the structure of worms? Where does the earthworm live? In what way is it of service to man?
2. Give some of the common names of earthworms. In what kind of soil do these creatures prefer to live?
3. In what respect do earthworms differ from the animals already studied?
4. What can you say of the size of earthworms? What is their color? How many segments has the body?
5. How does the earthworm travel? Describe the feet, and their position on the body.
6. How does it compare with the thousand-legged worm as regards the number of feet? How many feet has each segment?
7. Make a drawing of one segment, showing the location of the feet.
8. How is this worm enabled to burrow in the soil? What time is most favorable for the study of the angleworm?
9. Of what family is this animal a representative?
10. Where do most worms make their home? What exceptions have we to this?

Note Book Requirement

Write on page 76 a description of the earthworm.

CHAPTER IX

AIR ANIMALS

(Scripture Basis, Gen. 1:21, 22)

"Out of the ground the Lord God formed . . . every fowl of the air."

Lesson LXII

Migration of Birds

Yea, the stork in the heaven knoweth her appointed times; and the turtle and the crane and the swallow observe the time of their coming; but My people know not the judgment of the Lord. Jer. 8: 7.

This verse of Scripture refers to the migratory habits of some birds. These habits are not something they have learned, but are a result of instinct that has been given to them by the Creator. Such instincts are given for the well-being of the birds, and also for the benefit of the localities where they go.

What causes the birds to migrate? In most cases it is seeking a more suitable climate and a greater food supply. A few

birds in the tropics migrate as the seasons change from wet to dry, or from dry to wet. The migration of most birds is from south to north as winter passes into summer, and from north to south as summer changes to winter.

Migratory birds are sometimes called *birds of passage.* They always rear their young in the country where they spend the summer. Their arrival is always welcomed with delight, for it is a sign of advancing spring.

In North America, in the Temperate Zone, the robin is the first bird to tell us that spring is near, with summer following after. A little later, the bluebird comes to tell the same glad news. Those living in the Middle and the Eastern States hail these visitors with delight after having endured a long, cold winter.

FORK-TAILED SWALLOW

In other countries, other birds tell of the approach of summer. In whatever country you live, whether in the Old World or in the New, whether south of the Equator or north of it, you may observe the birds that come and go with the different seasons of the year. The birds of the same species start on their journey about the same date, even if the weather is not favorable, making two trips each year. If some of these birds live in confinement, they show a restless spirit when the migratory season comes on.

The number of species of birds that migrate is very large, neither is it limited to birds of long wings and strong powers of flight. The strongest flyers cross great bodies of water. Some pass from Europe over the Mediterranean Sea to Africa, others from North to South America. This does not appear so

difficult when we know that some birds can fly from fifty to one hundred and fifty miles an hour. The weaker flyers make the trip in shorter stages, taking a longer time.

Many birds return at regular times, to the same locality, and even use the same nests again, after having traveled hundreds of miles.

In their journeyings, birds are subject to various dangers. Great numbers are killed by heavy rains, hailstorms, sleet, and snowstorms. Many die from fatigue and starvation. The strong winds blow some to sea, where they fall into the water exhausted, and perish. But if they remained in the cold regions, they would die from exposure and starvation when winter comes.

It is the goodness and mercy of God that leads the birds from a country of want to a land of plenty, even though they must face the dangers of the way. It is the same goodness and mercy that gives us the impulse to start in the Christian life, to seek a better country, even a heavenly land. Long ago, the Lord sent word to His people, through Jeremiah, saying that they were not doing as well as the birds do in going from one country to another.

Swallows, ducks, and geese are found in nearly all countries, and are good examples of migratory habits. Notice the swallows on a frosty September morning. They have perched in the trees — a thing they never do during the summer months. They seem to be having a council concerning the long journey they are about to take; and, sure enough, early the next morning, before you are up, they are off. The "fly line" of some swallows is 10,000 miles long.

Many of the birds in the Eastern and Middle States pass the winter in the Southern States; but the bobolink goes as far south as Brazil. The golden plover rears its young in Arctic America, and winters in Patagonia.

This lesson should awaken a new interest in birds and their travels. Keep a bird calendar during the year, in which may be written your observations as to when the birds come in the spring and return in autumn. Also make a list of birds that stay with you all the year around.

One of our American poets was so impressed with the wonderful power that guides the birds in their journeyings, that he wrote a beautiful poem about it. Learn the name of the writer, read the poem, and see if you are impressed as he was.

Questions

1. What name is given to birds that go from one country to another?
2. What is the power called which prompts them to take these long journeys?
3. What is the usual direction of travel? In which country do they rear their young?
4. What birds are heralds of spring in North America? What birds tell you that spring is near in the country where you live?
5. How fast can birds travel? What large bodies of water do some of them cross?
6. What dangers beset migrating birds?
7. Of what journey is the migration of birds a fitting illustration?
8. How does the Lord compare the instinct of the birds with the intelligence shown by His people? Jer. 8:7.

Note Book Requirement

On page 77 write the lesson taught you by the migrating birds.

Lesson LXIII

Curious Birds' Nests

Yea, the sparrow hath found an house, and the swallow a nest for herself, where she may lay her young, even Thine altars, O Lord of hosts, my King, and my God. Ps. 84:3.

As a rule, the small birds, with delicate feet and slender bills, are the finest nest builders. All birds of the same species

build their nests alike from one generation to another. They use the same building materials, and select similar locations. Therefore lovers of birds have no trouble in finding the nests of those birds with which they have already become familiar.

Courtesy Lloyd E. Smith

A MOTHER HUMMING BIRD ON NEST

Birds, as well as people, have widely differing tastes as to where their homes shall be built. Some choose high tree tops; others, the low bushes or wayside hedges. Still others choose hollow stumps or tree trunks. Not a few build on the ground in grassy pastures. All these places have their special advantages for the birds that occupy them.

The choice of location depends somewhat on the dangers to which the occupants will be exposed. The young brood is a tempting meal for hawks, owls, snakes, and other animals going about

seeking what they may devour. Day and night, the parent bird carefully guards her precious nestlings.

Some nests are concealed among thick boughs and leaves. In the tropics, they are often hung on the outer twigs and branches, so that monkeys and reptiles can not reach them.

The location of the nest may depend also on the coloring of the bird. Those having bright, conspicuous colors build nests in such places, or on such a plan, that the mother bird will not attract attention while sitting on the nest. These bright-colored birds usually nest in hollow trees, or else build covered nests.

Plain birds build open nests, and use materials nearly the same in color as the body of the bird. Notice that the eggs in these open nests are not highly colored, and thus neither the nest nor the eggs are conspicuous. This is especially true of birds that build on the ground. The snipe's and the killdeer's nest are very plain, consisting of a few straws and sticks brought together without special arrangement; and the eggs are dull in color, with a few marks and streaks on them, so they resemble the nest and its surroundings. Eggs laid in holes, or otherwise concealed, are usually bright-colored or white.

WEAVER BIRDS AND NESTS

Certain birds have quite well mastered the trades of weaving, tailoring, and masonry.

Weaver birds live in different parts of the Old World, but are most abundant in Africa. Some of them weave two nests for each pair of birds, one nest being for the male to stay in while the female sits on the eggs, until he relieves her. Other weavers make one nest with two chambers in it. Still others, called the social weavers, construct an umbrellalike roof; and under such a roof, from eight hundred to one thousand nests have been found. The nests of all weaver birds are made of fibers, slender twigs, or grass, made more flexible by saliva from the mouth. A pair of these birds will stand on opposite sides of the home that they are constructing, and pass fibers through and through from one to the other. The nest is of globular form, and lengthened into a tube below, with the entrance at the bottom or the side.

TAILOR BIRD'S NEST

The tailor bird is an East Indian warbler inhabiting the cultivated districts, and living chiefly on insects that infest the country. It makes a very curious nest by either sewing a dead leaf to a living one, or by joining two neighboring leaves together so as to form a hanging pouch which remains attached to the branch by one or both leaf stalks. The threads used by these birds are generally twisted vegetable fibers or ordinary cotton threads. The bill serves as a needle in making the holes in the leaves, and for drawing the threads through. If a large enough leaf can be found, the free edges are sewed together. The lower part of the pouch contains the nest, which is made of soft materials, and is entered from above.

A number of birds handle the mason's trowel in building their nests of mud mortar. Some birds use mud with grass and other materials. The swallows are the best masons. One species build their nests under the eaves of barns, getting the damp mud from streams near. The sticky saliva of the bird causes the mud to cohere, and the swallow has a very strong house. The inside of the nest is lined with feathers and dried grasses.

Questions

1. Name the different places where you have seen birds' nests. What birds have you seen building their nests?
2. How do you think the parent birds regard their nests? Did both birds take part in building the nests you have seen made?
3. What kind of birds build the nicest nests? Why is this?
4. What determines the places where birds build their nests?
5. What guides them in their choice of materials?
6. To what dangers are the eggs and the young birds exposed?
7. How has the Creator enabled some birds to hide their bodies and their eggs?
8. What birds are specially noted for their skill in nest building? Describe the nest of at least one of these birds. Does their skill come from long practice and experience? Who taught them how to build?
9. Do the birds build as skillfully now as they did in Eden? Why?
10. What will the birds tell us if we question them? Job 12: 7-9.

Lesson LXIV

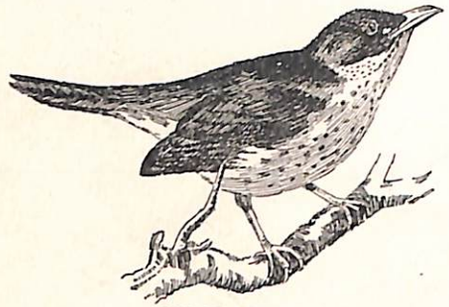
Voice and Plumage of Birds

He sendeth the springs into the valleys, which run among the hills. . . . By them shall the fowls of the heaven have their habitation, which sing among the branches. Ps. 104: 10, 12.

Gavest thou the goodly wings unto the peacocks? Job 39: 13.

The birds seem to be very happy and contented. They talk and sing in a language all their own, but which seems to be

well understood by them. The councils held and the concerts given are very interesting even to human ears. The councils of migrating birds are usually held just before their long journeys, or soon after the journeys are completed. The bird concerts are given in the happy summer days, during the rearing of the young. Some of the birds are excellent soloists. The wood thrush, the skylark, the mocking bird, and the nightingale are the best singers.



WOOD THRUSH

Notice the meadow larks, the robins, the bobolinks, or any of the birds that live in your neighborhood, and learn what you can of their language. You will discover that the parents speak to each other in certain notes, and to their children in others. The old birds have calling and answering notes, and still others used when their children are in danger.

By a little observation, you will be able to understand the language of the birds of your community, and can identify them when they are not in sight by listening to their conversation.

ROBIN

The voices of birds vary as much as human voices, or more. As with man, the voice denotes the character of the bird. Ugly birds have ugly voices. Birds of prey have sharp, shrill, disagreeable voices. The birds most useful to man in protecting his crops or cheering his heart, as a rule have melodious voices.

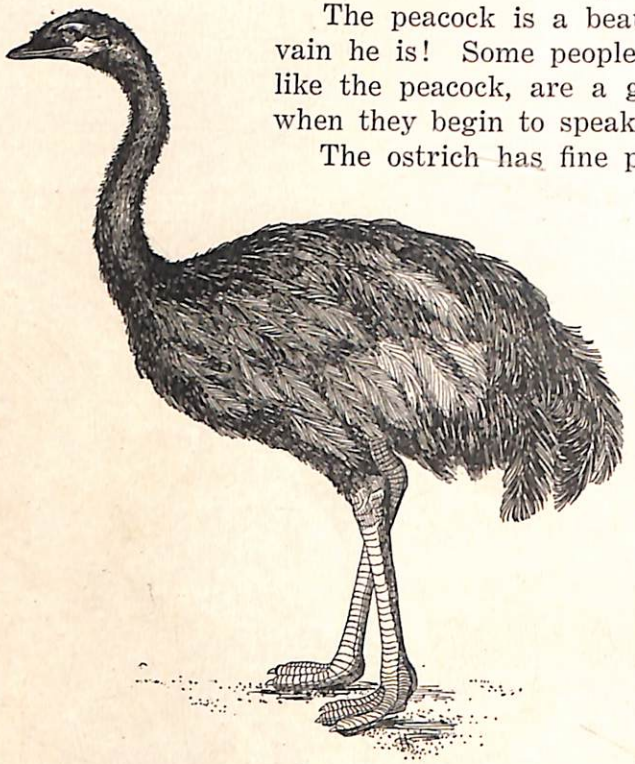
Some birds have the power to express great sadness and bitterness of spirit. Some of these the Lord has caused to inhabit countries and cities that have been destroyed on account of the wickedness of the people. Referring to Babylon and Nineveh, the Lord says: "Their houses shall be full of d o l e f u l creatures." "The cormorant and the bittern shall lodge in the upper lintels of it; their voice shall sing in the windows."

PEACOCK

The Lord says that during the thousand years when none but Satan and his evil angels inhabit the earth, "From generation to generation it shall lie waste; none shall pass through it forever and ever. But the cormorant and the bittern shall possess it; the owl also and the raven shall dwell in it." So we see that after man has been destroyed, for a thousand years doleful birds and other creatures will possess the ruins of cities, and continually utter their mournful cries, as if bemoaning the fate of man, who was appointed ruler of the animal creation.

The dress of birds, as well as their voices, is an interesting study. We find a great variety of styles among them. You can not judge a bird by its dress, any more than you can judge

a man by the clothes he wears. But among birds, as well as among men, we find, as a general rule, that those showily dressed are proud and selfish in their disposition.



OSTRICH

The peacock is a beautiful bird, but how vain he is! Some people beautifully dressed, like the peacock, are a great disappointment when they begin to speak.

The ostrich has fine plumage, but its disposition is not at all amiable. It has a great deal of pride, and very little sense. The Scripture says, "God hath deprived her of wisdom, neither hath He imparted to her understanding."

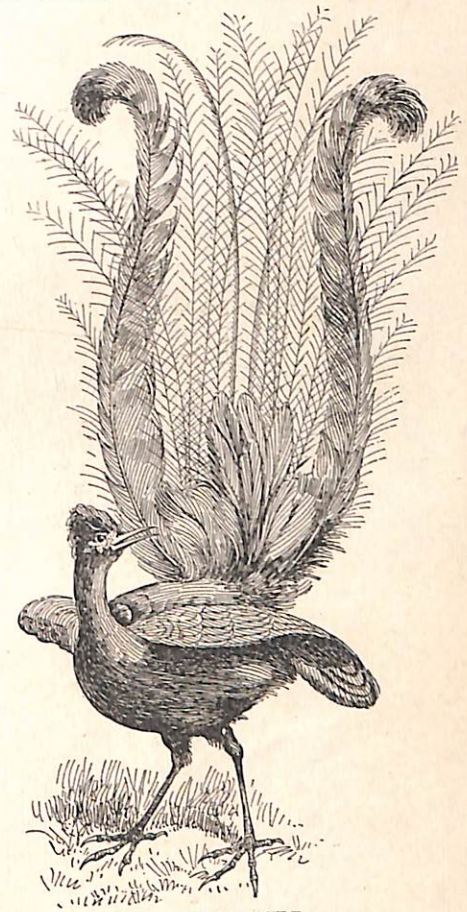
Parrots, pheasants, and humming birds are beautiful, but they are not gifted in song. The lives of many birds are ruthlessly taken to supply milliners with material for decorating the hats of women.

The bower birds of Australia wear lovely feathers; and they build bowers, by interweaving twigs and branches. These bowers form a promenade in which the males strut before the females while wooing their mates.

The lyre bird is another Australian beauty. The tail is made of long, elegant feathers, so arranged as to suggest the form of an ancient musical instrument called the *lyre*. This

handsome bird is an exception to the rule, in that it has ability to sing, imitating the songs of other birds.

The most beautiful bird of all is the bird of paradise. About twenty species of this bird are found in New Guinea and the neighboring islands. They are much admired for the golden plumes growing beneath their wings.



LYRE BIRD

The Creator never designed that man should nourish his naturally proud spirit by robbing birds of their plumage to adorn his body. We should seek beauty of character instead of beauty of person, and then we shall possess both in that day when our vile bodies shall "be fashioned like unto His glorious body." Neatness and plainness of dress is helpful in developing a righteous character.

Questions

1. What is the general disposition of birds? How is it manifested?
2. In what different ways do birds use their voices?
3. Describe the calling and answering notes of birds with which you are acquainted. Tell about the danger signals given in protecting their young.
4. Does the voice signify the character of a bird? Is this true of persons also?

5. Give examples of birds whose voices indicate gladness, sadness, or evil disposition.
6. What birds that have sad and doleful voices did the Lord say would mourn in desolated Babylon and Nineveh? Why? Isa. 13:19-22.

EMU

7. What birds will mourn for the condition of the earth during the thousand years that it will lie desolate? Why? Isa. 34: 8-16.
8. What variation is found in the dress of birds? Can you tell the disposition of a bird by its dress? Of a person?
9. Name some of the beautiful birds, and describe their plumage.
10. What kind of dress will be helpful to us in developing a righteous character?
11. What cruel injustice is suffered by the birds which reacts against man's spiritual nature?

Note Book Requirements

1. On page 84 describe the lyre bird and the bird of paradise.
2. Describe briefly the birds pictured on pages 80 and 81.

CHAPTER X

LAND ANIMALS

(Scripture Basis, Gen. 1:24, 25)

"And God said, Let the earth bring forth . . . cattle, and creeping thing, and beast."

Lesson LXV

How to Study Insects

Go to the ant, thou sluggard; consider her ways, and be wise. Prov. 6: 6.

This advice of Solomon to study the ant, and learn wisdom from her ways, is good advice to follow regarding all the insects about us. We have made some acquaintance with several families of the creeping, buzzing creatures that make up the nation called *insecta,* which means *divided,* or *cut into.* This refers to the insect's body being constricted between the thorax and the abdomen, and between the thorax and the head.

Those who devote their time to a thorough study of insects are called *entomologists,* and the study itself is called *entomology,* which means a *study of insects.*

But how shall we study insects? They will not object to our study if we treat them with due consideration. They are not to be killed, and their bodies thrust through with pins to fasten them to the wall or to the bottom of a case. Solomon does not tell us to study that way; but "go to the ant, . . . consider her *ways,* and be wise." The ways and habits of insects are what we are to study, and we can not do that when they are dead. We should study them when they are living and active, and as far as possible get acquainted with them in their own homes. This is the right way to study birds, beasts, and all of God's creatures.

AN ANT HILL

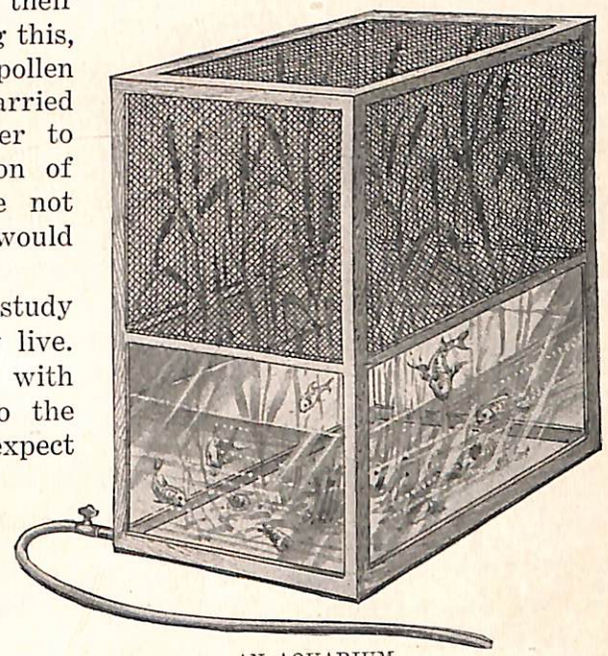
Before sin came into this world, there was no death; but under its reign, we are permitted to kill those creatures which are destructive to the food and property of man. Even men are imprisoned, and sometimes the life of one is taken who has killed a fellow being.

It is right to destroy the insects that feed upon the crops which are needful for food. It is right to kill birds of prey that would take the fowls from the poultry yard, and the wolf that steals the sheep and lambs from the fold.

By studying insects, we shall be better able to protect the orchards and the fields from the rapidly multiplying pests that would rob us of food. Sin has perverted the habits of creatures that God intended to minister only good to man. We shall find,

however, that some of the insects, by destroying their lawless relatives that forage on the farmer's crops, are very stanch friends of his, and should be fed and protected in reward for their valuable service. The ladybug, already studied, is a good example of this class of insects. To farmers who make application to the state agriculturist, thousands of these insects are sent without cost, that they may be set free in orchards and gardens, to destroy plant lice.

A number of different kinds of insects do not destroy their fellows, but spend their time in visiting the flowers, gathering nectar from them for their own use; and in doing this, they distribute the pollen which must be carried from flower to flower to insure the fertilization of seeds. If this were not done, the flowers would not perfect seed.



AN AQUARIUM

The best place to study insects is where they live. This is in harmony with the advice to "go to the ant," and not to expect that the ant will come to you. When at home, they act naturally. This plan is not always practical, however; and the next best thing is to provide a home for them as nearly like their own as possible. Such a place is called an *insectarium.* An aquarium makes a good insectarium for insects that live most of their time in quiet water, such as the mosquito and the dragon fly. Quite

a different home must be provided for the breeding of house flies and potato bugs.

Ponds and streams contain a surprising wealth of life. You may be quite well acquainted with the insect life of field, orchard, and garden; but here you will have a new world of insect life, easy to find, easy to collect, and easy to keep alive either in pools and streams or in an aquarium.

Go to any pond, lagoon, beach, pool, swamp, brook, or creek, and you will find aquatic insects in all situations. The collection will be better if these places are natural, with abundance of water plants growing in the edge of the water.

You can begin to collect water insects the first warm spring days. The search may be continued through spring, summer, and even late into November. But do not forget that the best place to study insects is in their natural homes. Sit quietly on the bank, and notice what happens in these insect communities. A pair of field or opera glasses, or a magnifying glass, is an aid in watching the behavior of surface insects. A net is useful in collecting them. Keep a note book with you, and make a record of the following points:—

1. Name of insect. If not known, give it one of your own.
2. Its place in its native home — surface, under surface, bottom, etc.
3. Date.
4. Weather — clear or cloudy, temperature, etc.
5. Water — clear, stagnant or running, etc.
6. Abundance.
7. Method of locomotion.
8. Feeding habits.
9. Enemies.
10. Other observations.

The field, orchard, and garden insects can be observed on the grain, trees, and vegetables. Visit these places frequently, keeping a record of your observations. When necessary, you can bring a twig covered with insects under cover, and place it in

water to keep the foliage green. Keep a good supply of the food plant in the water for the larvæ to feed on, and watch the insects pass through the different stages of development.

Questions

1. What advice did Solomon give concerning the study of the ant? Where did he say to study it? Should his advice be followed in studying other insects? Why?
2. What is the insect nation called? Why is it so named?
3. Give the insect families described in Book 1, and name a few members of each family.
4. How should we regard the lives of insects? When is it permissible to take the life of animals? Why?
5. What benefit is derived from studying insects?
6. Describe the insects as to their disposition and character. Into what two classes may they be divided? Name common examples of each.
7. Where is the best place to study insect life? When this can not be done, what plan is adopted? What is an insectarium?
8. What places have an abundance of insect life? What time is favorable for collecting water insects?
9. What instrument is valuable in observing insects? In collecting them? What records should be kept? (See "Collecting and Rearing Insects," in Supplement.)

Lesson LXVI

Butterflies and Moths

When Thou with rebukes dost correct man for iniquity, Thou makest his beauty to consume away like a moth: surely every man is vanity. Ps. 39: 11.

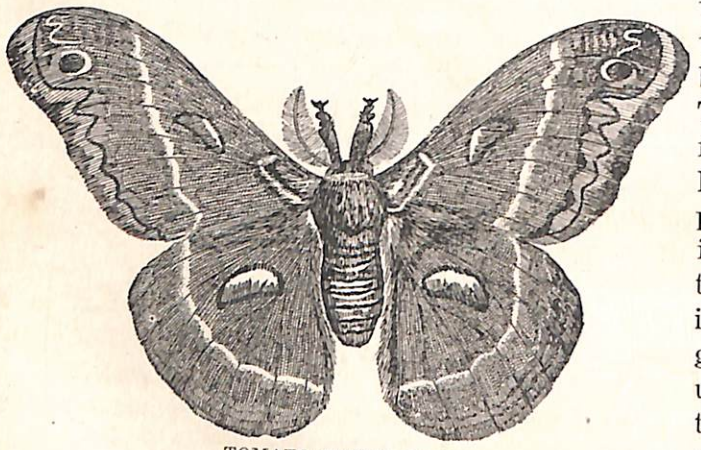
Both butterflies and moths are members of the scaly-wing family. The butterflies are the most beautiful members of this family; but with insects as well as with birds, usefulness does not depend on outward show. The scaly wings, as a rule, are not an industrious family.

You can generally distinguish between butterflies and moths by the position of their wings when at rest. The wings of moths are locked together by a tiny hook on the inner margin of one wing which fits into an eye on the inner margin of the other wing. The butterflies never have this arrangement. They hold their wings erect when resting, or keep moving them upward and downward.

TOMATO WORM LARVA

The antennæ of the moth differ from those of the butterfly. Examine several moths and butterflies, and notice the difference.

Moths pass through four stages of development,— egg, larva, pupa, and imago,— the same as the butterfly. While passing through these stages, they are subject to serious dangers. In the egg state, they are food for beetles and birds. The ichneumon flies sting the larvæ, and deposit their eggs in them; and these develop into ichneumon grubs, which eat up the larvæ. In the imago state, moths are devoured by birds, bats, and dragon flies; and the wonder is that any live long enough to deposit eggs to produce another generation.



TOMATO WORM MOTH

Butterflies usually fly by day, and moths by night. Moths are attracted by bright light. Thousands of them can be seen flying in confusion about the electric lights in the streets.

Some moths are very large, and some are very beautiful. They vary greatly in size. The atlas moth is the largest, measuring at least a foot from tip to tip of its wings. Some moths are very small, not larger than a house fly.

The common tomato worm is one of the most easily observed moth larvæ. It is a very ugly looking caterpillar, but is perfectly harmless, and can be handled without danger. It is easily reared by feeding on leaves where it is found. The larvæ burrow and make their cocoons in the ground, or above it, as the surroundings will permit. The ichneumon flies are developed from the ichneumon grubs that are parasites of the tomato worm. Watch closely, and you may see the ichneumon grubs boring their way out, and spinning their little cocoons over the body of their host.

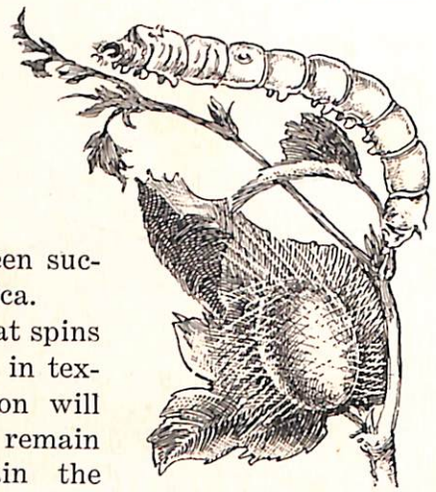
The most useful of all moths is the one that furnishes us with silk. Its common name is *mulberry silkworm*. The earliest history we have of this insect tells how Hoang-Si, an early emperor of China, requested his queen wife, Ling-Chi, to examine the threads from the cocoons, and test them to see whether they could be used as thread or not. This was hundreds of years before Christ. She collected a large number of the caterpillars, fed them herself, and learned how to reel their silk and make it into garments. For her discovery she was greatly honored, and ever afterward was called the "goddess of silkworms."

The wild silkworms were found living in the jungles of India. The Chinese kept their method of obtaining silk a secret for many centuries. They sold silk to the Persians, who carried it to the western nations without knowing how it was made or where the Chinese obtained it. After many years, the Roman ladies learned how to weave silk brought from Persia. The Roman emperors arrayed themselves in costly silken garments, and soon laws were passed prohibiting any one from wearing silk except royalty.

It was not till about 600 A. D. that other nations engaged in the silk industry. Death was the penalty to be visited on any

one who took silkworm eggs out of China. But finally a secret arrangement was made with two monks, who brought silkworm eggs to Italy in the hollow canes they carried. Silk culture spread over Greece and Syria, and into Spain and Sicily, reaching France in the seventeenth century.

The culture of silk was started in America about three hundred years ago, when James I sent to Virginia silkworm eggs, mulberry trees, and printed directions as to how to produce silk; but the effort did not prove successful. As time went by, many attempts were made to establish the industry in the United States, but there were many serious reverses. Severe winter weather killed most of the mulberry trees on which the silkworm feeds. It is only about seventy-five years that the manufacture of silk has been successfully carried forward in America.



SILKWORM LARVA AND COCOON

Now let us study the creature that spins the wonderful silken thread, so fine in texture, so durable in quality. Cotton will mildew and decay; but silk can remain soaking in water and yet retain the strength of its fiber. It is the strongest fiber known.

The silkworm is not really a worm, but a caterpillar. It was first reared in China, as far as known, but is now grown in Japan, Italy, France, Spain, and other European countries, and the United States. The silkworm moth passes through four stages,— egg, larva, chrysalis, and imago. The larva is first fed on the small, tender leaves of white mulberry or osage orange. It passes through four molting periods, shedding its old skin each time. The young caterpillars eat so much and grow so fast that they must change their coats every few days.

When a silkworm is full-grown, it is ready to spin its cocoon. It then loses its appetite, becomes restless, and seeks a quiet place. It moves its head from side to side to find objects to which it can fasten threads, like the guy ropes of a tent, within which to build its cocoon.

The insect works steadily until the cocoon is finished. In twenty-four hours the body is nearly hidden, and the work is completed in about three days. When it has finished spinning, it is one and a quarter inches long. The chrysalis is formed within the cocoon, which bursts in two or three weeks, allowing the moth to go free. It gnaws a hole through one end of the cocoon, and passes out into the world a full-grown moth, ready to lay eggs for the next generation.

The female silkworm lays half her eggs, then rests a few hours before laying the remainder. One moth will lay from three to four hundred eggs. Her short life of two or three days as a moth, is spent in a space less than six inches in diameter, for she has no disposition to fly or roam about.

Questions

1. To what family do the butterfly and the moth belong?
2. Distinguish between these two insects.
3. Name the stages of development in the moth and the butterfly.
4. To what dangers are they exposed during the metamorphosis?
5. Describe the common tomato worm and its metamorphosis.
6. Give the history of the discovery of the silkworm, and of the growth of the silk industry.
7. How does silk compare with other fibers as to strength and durability?
8. Where was the silkworm first reared? In what countries is it now reared? What is its food?
9. How many stages are there in the development of the silkworm? Name them.
10. Describe the growth and molting process of the silkworm.
11. Describe the building of the cocoon. How long does the moth remain in it? How does it make its escape?
12. In what ways may the silkworm be an example to us?

13. What is the wise woman's most costly and valuable clothing? Prov. 31: 25.

Note Book Requirement

On page 87 write the life history of the common tomato worm.

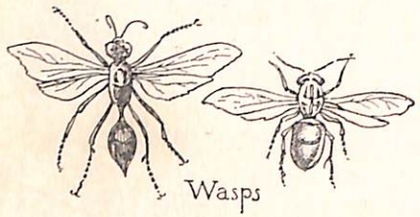
W&B

Lesson LXVII

Insect Friends

And I will rebuke the devourer for your sakes, and he shall not destroy the fruits of your ground; neither shall your vine cast her fruit before the time in the field, saith the Lord of hosts. Mal. 3: 11.

Those insects which are a benefit to the farmer, to the gardener, and to the orchardist, we call insect friends. They may, however, be very unfriendly to their neighbors, and in destroying them they exterminate the pests that do injury to the crops.



Wasps

In this lesson, we shall enumerate a few of these friends, beginning with those that are most peaceful in their disposition.

The bees are man's best insect friends; and while they do sting occasionally, yet it is usually in self-defense. This is true not only of honeybees, but also of bumblebees, carpenter bees, potter bees, wasps, hornets, and yellow jackets, which are all closely related to honeybees.

The honeybees are the most industrious workers of all these bee and beelike friends. It is interesting to watch them when they are at work. Follow one for five minutes, and see how many flowers it will visit, on an average, each minute. Notice what kind of flowers it visits, and how the work is performed in each flower. The bee is after the honey at the bottom of the

flower tube; but as it reaches down, pollen grains adhere to its head, wings, and legs, and are carried from one flower to another. Some of these pollen grains fall upon the moist surface of the pistils as the insect brushes past them, and these grains send their little tubes into the seeds within the pistil. This causes the seed and fruit to develop much better than where bees or other insects are not permitted to visit the flowers.

You can prove this to your satisfaction by planting in the school garden two clumps of white clover or alfalfa for the honeybees, and red clover for the bumblebees. Cover one clump of each kind with netting before any of the blossoms open, leaving the others uncovered. Count all the heads that mature in each clump, and then thrash out the seeds, placing them in small bottles, and label them so you will know which seeds were aided in their development by the visits of the bees.

The same plan can be carried out with strawberries and other garden plants. Try the experiment on a fruit tree, covering with mosquito netting small branches of plum, peach, cherry, pear, and apple. The result will be that more and better-developed fruit will grow on the uncovered branches than on those that are covered.

Hornet

With the bumblebees, the hornets, the wasps, and other beelike insects, the queens alone live through the winter; but not so with the honeybees. In each of their hives, there is an army of workers ready to pour forth into fields, orchards, and gardens at the proper season, to do the work required.

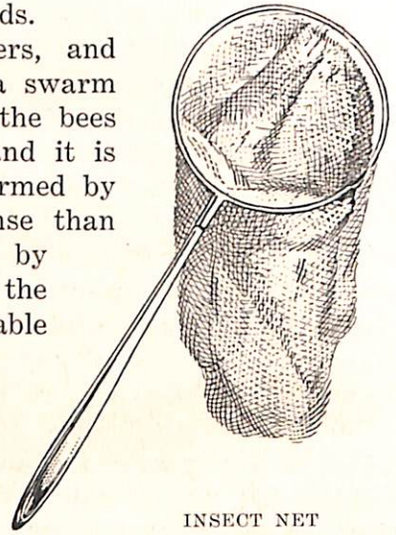
Attempts have been made to raise fruits on a large scale where there were no bees; but year after year no crops were produced. Afterward bees were introduced into the same locality, and abundant crops were gathered. If the weather is cold, windy, or rainy, during the blooming season, so that the bees can not fly, the harvest will be greatly lessened.

The honeybee is not a native of this country, but was sent over from Europe, and has now spread over the whole conti-

nent, from the Atlantic to the Pacific. Besides the honeybees, there are about five thousand different kinds of bees. But most of them do not live in colonies; and those that do, are not so well organized as the honeybee and the ant.

Most of the hornets and wasps do not live on pollen and honey, but on other insects and spiders, which they paralyze by stinging them, and afterward kill and devour them. The mud wasps and white-faced hornets kill thousands of noxious insects that would rob our orchards of fruit, and therefore we must acknowledge them as our friends.

Men who raise melons, cucumbers, and tomatoes under glass have to keep a swarm of bees to fertilize the flowers; but the bees do not thrive in such confinement, and it is now thought this work can be performed by bumblebees, and at much less expense than by honeybees. This could be done by catching a few queen bees late in the fall and providing them with suitable nests.



INSECT NET

Moths and butterflies do much the same work for man as do the bees, and therefore must be classed among his friends. Boys should not kill butterflies. The insect net is to be used only for capturing them to examine. After examining them, set them free again, that they may go on with their good work. Most of these insects are harmless. The mourning cloak butterfly lays eggs which develop larvæ that do some damage to shade trees, as the elm, the willow, and the poplar. The cabbage butterflies are the most serious pests, destroying and feeding on cabbage and cauliflower, and also on nasturtiums.

The ichneumon flies, of which there are thousands of species, help to make up the hosts of friends that protect our food supply. These insects are parasites; and by depositing their eggs in the

larvæ or among the eggs of other insects, they destroy the larvæ.

The ladybugs we have already described as very useful in destroying plant lice, so ruinous to the foliage of many fruit trees and garden plants. The beetles are the little insect lions that go searching over trees and plants, destroying the caterpillar larvæ wherever found. The lion beetle, the tiger beetle, and the bombardier beetle are three of the bitter enemies of other insects, and yet they do friendly service for man.

LADY BEETLE

The dragon fly is also to be numbered among our insect friends. It does not protect the orchard and the garden, but it helps to make life more happy by destroying the troublesome, annoying gnats and mosquitoes that invade our homes.

Surely we have an army of insect friends. What a mighty host are battling against the insect neighbors that, if unhindered, would take away our daily bread!

Questions

1. What two classes of insect friends assist us in our labors?
2. Name some of the insect friends that do not destroy their neighbors. Name some of those that do.
3. Which insect is the most industrious worker? Name its near relatives. How do they differ from the honeybee?
4. What experiments show the value of these insects in fruit raising? In what way might the bumblebee help in greenhouses?
5. What service do butterflies and moths render?
6. Explain the work of the ichneumon flies, and the aid they give us.
7. Of what benefit are the ladybugs? How can they be secured?
8. What beetles help in destroying harmful insects?
9. Describe the dragon fly's service, and give its life history. (See Book 1, lesson 97.)
10. Who directs this army of insects in their ministry in our behalf? Mal. 3:11.

Lesson LXVIII

Insect Enemies

He spake, and the locusts came, and caterpillars, and that without number, and did eat up all the herbs in their land, and devoured the fruit of their ground. Ps. 105: 34, 35.

As you have formed the acquaintance of some of our insect friends, we will now introduce to you some of our insect enemies. A knowledge of these will assist us to counteract their efforts to torment our bodies and rob us of our food.

Clothes Moth

House flies, mosquitoes, gnats, fleas, lice, and bedbugs are some of our enemies; but with these we are more or less familiar, and therefore we will pass on to those enemies that live in the garden, the orchard, and the field.

The *clothes moth* is a serious enemy of ours, because it destroys our clothing. This moth has a history, for Job speaks of "a garment that is moth-eaten." This destructive creature is still active; and the apostle James, speaking of the rich who live just before the second coming of Christ, says, "Your riches are corrupted, and your garments are moth-eaten."

The clothes moth devours woolen clothing and furs. The amount of damage it does each year must reach into millions of dollars, in spite of all effort made by careful housekeepers. By searching in attic, storeroom, stable, poultry house, or woodshed, you will find the moths and the larvæ where there are scraps of woolen cloth, fur, hair, or feathers. Place your specimens in a wide-mouthed bottle with a little piece of black woolen cloth, and cover the top lightly with some cotton gauze. Watch the development of the larvæ, and examine the cloth for the tiny white eggs, scarcely visible to the naked eye.

The case of the moth is made very small at first, to fit the tiny larva; but it is extended at both ends as the occupant

grows. When the case becomes too tight, it is split along the sides, first at one end, then at the other, and new triangular gores are inserted. If you change, several times, the color of the cloth on which the larva feeds, it makes a coat of many colors.

The moth produces but a single brood in a season, in northern United States, laying its eggs from June to August. The pupa is formed in the case, and the pupal stage lasts about three weeks. The moth eats nothing the few days it lives, but deposits its eggs upon materials that will furnish food for the larvæ.

LARVÆ OF CODLING MOTH

When a house is once infested, it can not be ridded easily of the pests hidden in cracks and crevices. Here "an ounce of prevention is worth a pound of cure." Clean, wholesome premises, where no material is scattered about on which the larva can feed, are the best precaution that can be taken against its occupation of our homes.

We shall have to pass by the cockroaches, which eat everything within reach, even to bookbindings in the libraries. We must also omit the ants that often invade our homes, eating and spoiling the food in our pantries.

We are already acquainted with the plant lice that infest our gardens, and that are devoured by the ladybug; therefore we shall not consider them further in this lesson, but study a few of the more common enemies not already studied.

The *codling moth*, or apple worm, as it is commonly called, is an enemy of man, because it robs us of apples. Examine the trunk of a large apple tree. With a knife, loosen a few of the rough patches of bark. You will find smooth, silk-lined cells, just the right size to hold the small, pinkish white, black-headed larva within. Some of the cells may be empty, with a hole in them. Some insect-eating bird has made a breakfast out of these robber insects before they had a chance to become moths and lay eggs for another generation.

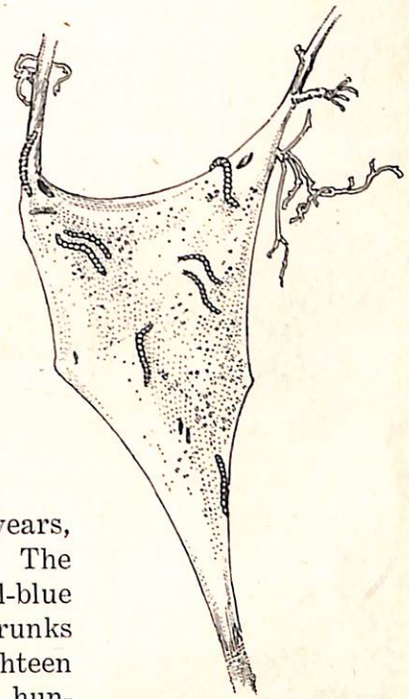
PUPA OF CODLING MOTH

The eggs are usually deposited in the calyx of the apple blossom, and there they hatch, and the result is that the blossom develops into a wormy apple. After the larva has become full-grown, it bores its way out, and makes a cocoon in the trunk of the tree where it was first found.

Watch the woodpeckers and other birds examining the trees of the orchard in search of food. The downy woodpecker is the most faithful sentinel that guards the orchard, and certainly he should be protected in his work. He earns much money for the owner of the orchard. What salary do you think this bird gets during cold winter days?

The *tent caterpillars* infest apple and wild cherry trees. You can easily observe a colony of thousands of them living a social life in a weblike tent in the forked branches. They do not eat the apples, but devour the leaves that are so necessary to the life and health of the trees.

After the larvæ have finished eating the leaves, they scatter out to fences and buildings, and in the cracks and crevices spin their cocoons. Within, they change to pupæ, and in about three weeks the moths appear. They fly about the apple trees, and deposit their eggs in belts of about three hundred around the small twigs. By collecting the twigs and placing them in a vase of water and supplying fresh leaves for food, you can observe the life of these insects very easily.

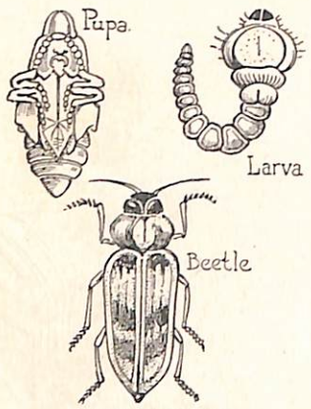


TENT CATERPILLARS

The *insect borers* are very destructive to fruit trees. There are many kinds, named after the trees into which they bore. The peach-tree borer can be located by its gummy chips at the base of the tree. It bores into the trunk just below the ground. In a few years, the tree is dead, and topples over. The moths look somewhat like the steel-blue wasps. They lay their eggs on the trunks of peach and plum trees, about eighteen inches from the ground. Several hundred are deposited by a single female. The eggs are brown. They are glued to the bark, and hatch in about a week.

The little larva borer crawls into a crack, and bores down to the juicy inner bark, where it remains feeding for about ten months. It then crawls out, and makes a brown cocoon on the trunk, close to the ground. After about three weeks, it comes forth a moth, and repeats the history of its mother. The moths may be seen during the day visiting the flowers, and gathering nectar or pollen.

The round-headed apple-tree borer of the apple and quince, and the flat-headed apple-tree borer, that sometimes attacks the pear, plum, and peach trees, also the pear-tree borer, are serious enemies to the orchardist, as it is difficult to get at them. These borers are beetles, and do their boring in the larva stage. You will be able to locate them by their sawdustlike borings. You will also find the beetles running over the trunk and branches of the tree; and by close observation, you may see them depositing their eggs under the scales and in the cracks of the bark.



BEETLE BORER

The borers may be destroyed by using a knife to cut them out or a wire to pull them out. The knife will not do the damage that would be done by the borers, and the cuts in the trees will usually heal over.

Cutworms are the caterpillars of the little owl moths, which do their damaging work at night. Their plan of work is to cut off the tender plants of the garden even with the ground. The eggs are deposited on plants near the ground, during the latter part of summer. The larvæ at first feed upon tender roots of grasses and other plants; but when spring arrives, they are about an inch long, and ready to enter upon their destructive campaign. Scrape away the soil from the base of a wilted plant, and you will usually find the culprit. If vegetation is scarce, the cutworm will climb vines, berry bushes, and trees, eating the leaf and fruit buds. Garden plants, when young, can be protected by placing stiff cardboard about them, pressing it one inch into the soil, and leaving two or three inches above the ground. Young trees may be protected in the same way; or tin cans with both ends cut out may be placed around them.

Cut Worm

The *snout beetles* are very destructive to apples, peaches, apricots, plums, cherries, and grapes; and some of them infest nuts and acorns. The plum snout beetle is the best for observation. This beetle first digs an oblique hole in the fruit with its snout. It then lays an egg in it, pushing it to the bottom with the long beak. After that it cuts a crescent-shaped flap on one side of the egg to prevent the growing fruit from crushing it. The whole operation takes about five minutes. The egg hatches, and the larva burrows to the stone of the fruit, and feeds about it, causing the fruit, except cherries, to fall before it is ripe. The larva attains full growth in five weeks, and then burrows its way out of the fallen fruit into the ground, from four to six inches deep. Here it passes through the pupal stage, and emerges the same season, a little, rough, brownish beetle.

San Jose Scale enlarged

The *scale insects*, called *mealy bugs*, *scale bugs*, and *bark lice*, are very destructive pests. They resemble plant lice, and live somewhat as they do. As the general name signifies, they appear as scales on the bark, leaves, and fruit of plants; and, like plant lice, they subsist on the juices of plants, extracting them with their sucking mouths.

The San Jose scale takes its name from the San Jose Valley, where it was first introduced with trees imported from Chile. Its original home is thought by some to be Australia, and by others to be either China or Japan.

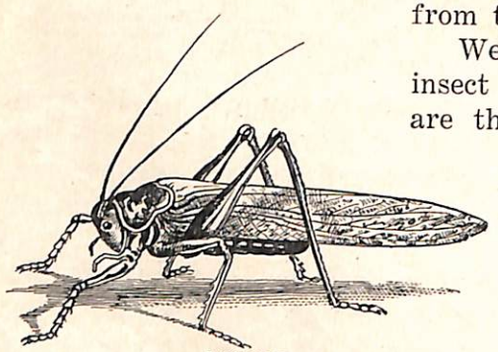
The insect is very small, and covers itself with a circular scale of an ashy gray color. The young are brought forth alive instead of from eggs. There are four or five generations a year. It has been calculated that one female scale may be the progenitor of three billions in one season. No wonder that it is so destructive, and such a dreaded pest!

The young crawl actively about for a short time, and each succeeding generation covers the new growth of leaves and fruit on the trees. A tree infested with scale has the appearance of being dusted over with ashes, and each speck is a tiny pump sucking the sap.

We shall pass the plant lice — aphides — without further description, as they have been referred to in other lessons; also the cabbage butterfly, the squash bug, and the striped cucumber beetle. These are all enemies of the gardener with which we are more or less familiar, and which we can easily study and observe.

The *Colorado beetle,* or potato bug, is an enemy with which the farmers in many districts must battle if they would secure a yield of potatoes. The *chinch bug* is destructive to wheat, and causes the farmers of the United States a loss of many millions of dollars each year.

Locusts and *grasshoppers* do great damage to grain crops from time to time.



LOCUST

We have studied but few of the insect enemies of man, those which are the most common pests. You should take time and pains to observe these, and others that may live in your community, and to learn what means can be best used to check their ravages.

We do not expect that these pests will decrease, but that they will increase. This is one of the signs that the end of the world is near.

In times past, God has used troublesome insects to punish the wicked. This was true when the plagues fell upon Egypt, and when the Canaanites were driven out of the land before the children of Israel.

God promises, to those who believe and obey Him, protection of their crops against the ravages of devouring insects. He says, "I will rebuke the devourer for your sakes, and he shall not destroy the fruits of your ground; neither shall your vine cast her fruit before the time in the field, saith the Lord of hosts."

Questions

1. Give the life history of the clothes moth. What damage does it do? How can it be kept from occupying our homes?
2. What harm is done by cockroaches?
3. Describe plant lice and the injury they do. What insect destroys them?
4. Name the larvæ of two moths that are enemies to the apple tree. Which eats the apples? Which eats the leaves? Give the life history of each.
5. What bird destroys the larvæ of these insects?
6. Name the insect borers. What trees do they damage? How may these borers be destroyed?
7. Give a description of the cutworms, and the harm they do. How may plants be protected from them?
8. Describe the snout beetles. Give the life history of the plum snout beetle.
9. Describe the scale insects. What is the life history of the San Jose scale?
10. Mention two insects that destroy garden vines.
11. Give the life history of the Colorado beetle. (See Book 1, lesson 98.)
12. What insects destroy wheat and other grain crops?
13. What will be the future of this insect invasion against man?
14. Has the Lord ever used insects to punish men? Ps. 105: 34, 35; Joshua 24: 12.
15. What promise of protection against these insect enemies does the Bible contain, that will be fulfilled just before Christ comes? Mal. 3: 11.
16. When did the Lord do a similar work for Israel? Joel 2: 25-27.

Note Book Requirement

On page 86 describe the plum weevil and the gallfly, and tell whether they are friends or enemies of man.

Lesson LXIX

Fur-Bearing Animals

Unto Adam also and to his wife did the Lord God make coats of skins, and clothed them. Gen. 3: 21.

The fur-bearing animals render service to man in providing warm clothing to protect his body from the severe cold weather. This is especially true in the colder regions in the Arctic Zone.

When did man first wear the skins of animals for clothing? and what made it necessary for him to do so? In the beginning, our first parents were clothed with garments of light; but after they yielded to the temptation of Satan, and lost their innocent, righteous characters, they were deprived of their garments of light. "And the eyes of them both were opened, and they knew that they were naked; and they sewed fig leaves together, and made themselves aprons." But these garments made of fig leaves were not warm enough to protect them from the cold weather that afterward came; so, as the Bible tells us, the Lord permitted them to use the skins of animals for clothing.

It was on account of sin that this great change in the climate was brought about. Taking the life of the animals for clothing was designed to impress upon man the terrible nature and results of sin. Later the lamb and other animals were offered as sacrifices for sin, all pointing to the Lamb of God, who was sacrificed that man might be redeemed from his sins.

Afterward, animals were killed for food also. While this was permitted, and is still necessary in some localities, yet it is carried on to great excess, to satisfy man's appetite. Flesh food, though contaminated with disease, is the main article of diet with many, notwithstanding the fact that an abundance of fruits, grains, and vegetables can be produced almost everywhere.

Wool from the sheep's back can be made into garments that will keep the body sufficiently warm, without the use of furs.

By depriving the sheep of its woolen jacket during the warm summer, and giving it to man to wear during the cold winter, a favor is shown to both, and no loss of life is occasioned by the transfer.

Some of the more common fur-bearing animals,— squirrels, foxes, beavers, raccoons, badgers, wolves, bears, etc.,— you are already familiar with; but we will now describe a few of those

OTTER

that are less common or live in remote districts, and whose furs are highly prized.

The *otter* is a jolly, good-natured creature, and enjoys coasting down hill during the wintertime. It is about three feet in length, has webbed toes, and lives much of the time in the water. Some otters live by the sea, others by fresh water streams. They are expert fishers, and fish is their chief article of diet. In China and India they are tamed, and catch fish and bring them to their masters. The nest of the otter is composed of dry

leaves, and is built near the shore, so that in case of danger the mother with her family may plunge into the stream and hide among the vegetation along the bank. The color of the otter varies according to the angle of the light shining upon it, but is usually of a rich brown tint intermingled with whitish gray. The fur is so warm and handsome that it is in great demand.

MINK

The *mink* seems equally at home in the water or on the land. It eats not only fish, but explores the swamps for frogs and lizards, and digs all sorts of beetles, grubs, and earthworms from the black, mucky soil. Its fur is brown.

The minks build their nests in holes among the rocks, or inside hollow logs or stumps hidden among the flags and reeds that grow on the banks of streams. The young stay with the mother through the warm weather, during which time she teaches them how to hunt and fish. When the sons are grown to the size of their mother, they become restless, and start out to hunt independently, being gone a week or more before they return.

The *American sable,* also called the *pine marten,* possesses a rich brown coat of fur. This creature is about two feet in length, and loves best to live in the pineries, whence it derives the name *pine marten.* In these thick, evergreen forests it loves to climb the dead leaning trees, and leap over into near-by tree tops, chasing the red squirrels in the branches. Then in an instant it is down to the earth again, and bounds off on the

trail of a rabbit or a hare or a squirrel. These constitute an important part of its bill of fare. It also kills a great many birds, and is especially fond of partridges.

The nests of the sables are made high up in the holes of old trees. These animals seem quite disposed to occupy, without permission, the nests of squirrels and large woodpeckers; and with their noses poked out of the holes, they seem to love to watch whatever proceedings are going on below. Their nests are composed of moss and leaves placed in the bottom of the cavity. The marten, like the beaver and the otter, objects to civilization, and refuses to inhabit woods that have been trodden by the foot of man. If a beaver or an otter finds a man's tracks

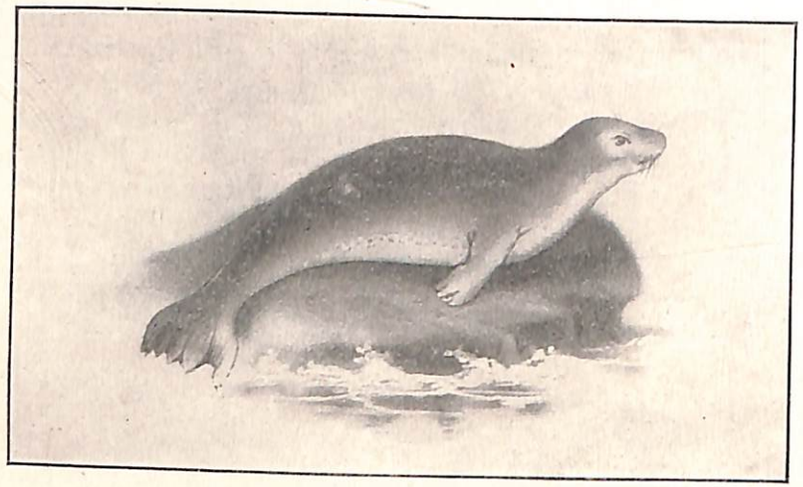
SABLE

near its home and playground, it moves to some other point along the stream, and establishes new quarters.

The *fur seal* is the most important of all the fur-bearing animals. It is about six feet long when full-grown. Its body is covered with a very fine, soft under fur, with a coarser, longer

growth of hair overlying it. The color of the fur varies from chestnut brown to black.

The fur seal breeds on Pribilof Islands in Bering Sea. It is a migratory animal, spending the summer and fall at its breeding grounds, and passing the winter at sea, going down

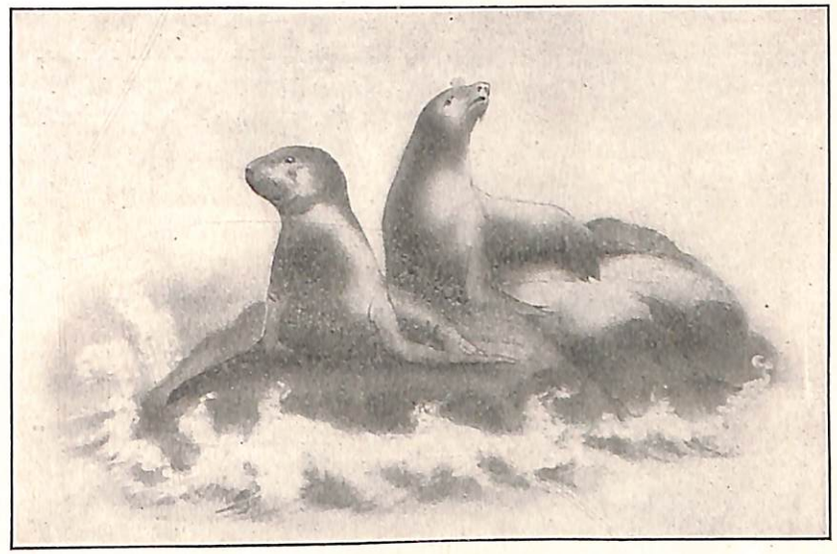


FUR SEAL

the coast as far as southern California. The females reach full size at two years of age, and the males at seven.

The summer life on the breeding grounds is very interesting. During the month of May, the males arrive, and take up quarters on the bleak, rocky beaches. In June the females come in. Each male takes a few females under his care and protection. Shortly after the arrival of the females, the young "pups" are born. As soon as a pup is sufficiently strong to be left, the mother repairs to the sea to feed, and returns now and then to see how her child is faring. When sufficiently old and strong to care for themselves, the young pups go to sea and secure their own food.

The *hair seal,* commonly called the *sea lion,* is closely related to the fur seal, but it is not valuable for its fur. This is the common sea lion of the California coast, and the one usually seen in menageries and zoölogical gardens. This seal barks like a dog; other species roar like a lion. During the breeding



SEA LIONS

season all seals fight and quarrel, and their roaring or barking sounds as if a fierce battle were on.

The walrus is closely related to the seal. It is larger than the seal, and also fatter and clumsier. It is provided with enormous tusks in the upper jaw, which are its canine teeth. The Atlantic walrus is a little over ten feet in length. It has a thick, heavy body covered with scanty hair, a short neck, but no visible ears or tail. Its tusks are twelve to fifteen inches long. It uses its tusks for digging mollusks out of the mud, and also for dragging its clumsy body upon the ice or over shelving reefs among the breakers.

The walrus is often seen in large herds lounging and tumbling about on the shore, all roaring and grunting together. When sudden alarm is sounded by the sentinel, they all go tumbling into the sea. The young are born on the shore during spring or early summer, at which time the old ones often go for weeks without food, and remain out of the water. If attacked by an

WALRUSES

enemy, they roll their young babies into the sea; then, seizing them in their mouths, they dive and swim away beneath the surface of the water.

The Eskimos who live in the cold northlands derive their food and clothing from these creatures that inhabit the same region. Thus God has made provision for the sustenance of man wherever he may live.

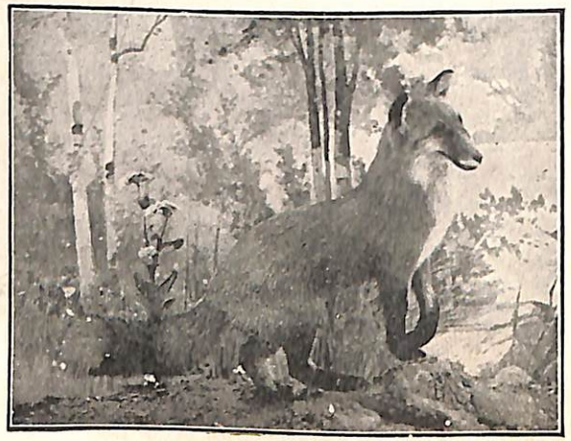
MISS COLUMBIA AND HER PET SEAL

Questions

1. What made it necessary for the life of animals to be taken to clothe man?
2. What important lesson was this designed to impress upon him?
3. How have the pride and selfishness of man caused him to abuse the privilege granted to use animals for food and clothing?
4. What abundant provision makes unnecessary such excess in taking the life of God's creatures?
5. Name some of the common animals that provide commercial furs.
6. Describe briefly the following fur-bearing animals: otter, mink, American sable, and fur seal.
7. What other animal is closely related to the fur seal? Describe it.
8. Give a description of the walrus, and compare it with the seal.
9. What provision has been made for feeding and clothing the people living in the cold regions of the North?

Note Book Requirements

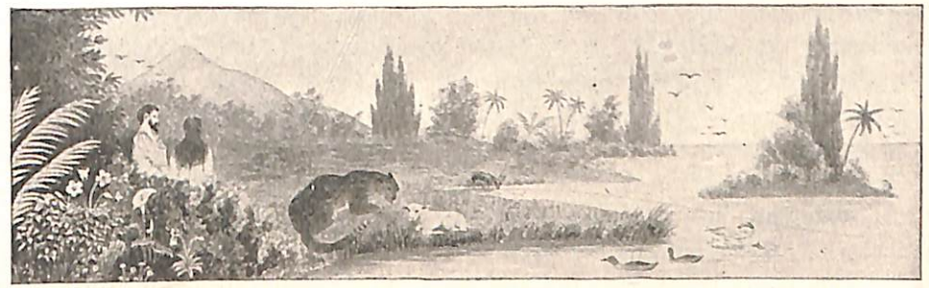
1. Review the lessons on gnawing and flesh-eating animals, and on page 88 write a list of each.
2. Write on page 89 a brief description of the rhinoceros and the hippopotamus.



CHAPTER XI

MAN

(Scripture Basis, Gen. 1:26-28)



"And the Lord God formed man of the dust of the ground."

Lesson LXX

In the Image of God

And God said, Let Us make man in Our image, after Our likeness. . . . So God created man in His own image, in the image of God created He him. Gen. 1: 26, 27.

Created in the image of God! This is a wonderful thought. After creating all the animals, marvelous in structure as many of them are, God proposed to make another being, different from any that He had yet created. He said to His Son, "Let Us make man in Our image, after Our likeness."

This language of the Father to His Son would indicate that They both have the same image, or bodily form. This is in harmony with the words of Paul, who, in speaking of Christ's

form, says that He, "being in the form of God, thought it not robbery to be equal with God;" and in another place, that He "is the image of the invisible God." In still another place he makes it very plain, speaking of Christ as "being the brightness of His glory, and the express image of His person, and upholding all things by the word of His power." Man, then, was created in the form and image of the great and mighty God, and in the image and form of His Son. Is it not indeed marvelous to contemplate, as we look at the myriads of worlds that shine like gems at night, that we have the same form and image as the One who upholds them all?

Some would tell us that God has no body, no form. But this is not the testimony of John the revelator, who was permitted to see Christ in vision. This is his testimony: "I saw . . . One like unto the Son of man, clothed with a garment down to the foot, and girt about the paps with a golden girdle. His head and His hairs were white like wool, as white as snow; and His eyes were as a flame of fire; and His feet like unto fine brass, as if they burned in a furnace; and His voice as the sound of many waters." From this description, we learn that Christ has a body, and the parts of His body are the same as ours, having head, eyes, and feet, which were visible to the prophet. This glorious Being was also seen in vision by Isaiah.

"Man was to bear God's image, both in outward resemblance and in character. Christ alone is 'the express image' of the Father; but man was formed in the likeness of God. His nature was in harmony with the will of God. His mind was capable of comprehending divine things. His affections were pure; his appetites and passions were under the control of reason. He was holy and happy in bearing the image of God, and in perfect obedience to His will.

"As man came forth from the hand of his Creator, he was of lofty stature and perfect symmetry. His countenance bore the ruddy tint of health, and glowed with the light of life and joy. Adam's height was much greater than that of men who

now inhabit the earth. Eve was somewhat less in stature; yet her form was noble, and full of beauty. The sinless pair wore no artificial garments; they were clothed with a covering of light and glory, such as the angels wear. So long as they lived in obedience to God, this robe of light continued to enshroud them."

The first pair not only had the outward image of God, but they were covered with glory akin to that which surrounds their Maker. In character also they were in the likeness of the Creator; but having lost this, they lost the light that clothed them.

The wise man told the truth of the matter when he said, "Lo, this only have I found, that God hath made man upright; but they have sought out many inventions." God made man of upright stature and upright character; and it is his duty to maintain both.

He only, of all the animal creation, was created to stand and walk erect. This fact alone places man in a distinct sphere, above the animals. But the intellectual and spiritual nature imparted to man at his creation left him immeasurably above the animal realm, and makes the human family sons and daughters of God.

Let us be thankful that the image of God is not entirely effaced; that the physical likeness, though marred, is still retained. It is hoped the result of these studies in physiology will be that the boys and girls will so conform to the divine likeness in their physical, mental, and spiritual growth as to reflect fully the image of Christ, that He may at His coming change their mortal bodies, and fashion them like His most glorious body.

Questions

1. From what was Adam made? Eve? Gen. 2:7, 18, 21-23.
2. In whose image were they made? Gen. 1:26, 27.
3. Give proof that God and Christ have the same form of body. Phil. 2:5, 6; Col. 1:13-15; Heb. 1:3.
4. What eyewitnesses have testified of the form of God and Christ? Give briefly the testimony of each of these eyewitnesses. Rev. 1:11-16; Isa. 6:1-4; Ex. 33:18-23; Eze. 1:26-28.

5. Did our first parents have glorified bodies when they were in their Eden home? Describe Adam and Eve as they appeared before they were driven from the garden of Eden.
6. What part of God's image did they lose when they sinned? What does man retain of God's image, although now greatly marred?
7. In what way was man, when first created, elevated physically above all the animals?
8. What influence should the great truth that we are made in the image of God, have upon us? Can God's image in us be fully restored?
9. What should be our object as we study man's body?
10. If this purpose is kept in view, what change will take place at the second coming of Christ, that will completely restore the image of God in man? Phil. 3: 20, 21; 1 Cor. 15: 51-53.

Lesson LXXI

A Holy, Living Temple

The temple of God is holy, which temple ye are. 1 Cor. 3: 17.

Not only did the Creator form our bodies in His image, but He wished them to be temples in which He could dwell by His Holy Spirit. Some do not seem to know that their body is designed to be God's holy temple; for they act as if it belonged to them and they had a right to do with it as they please. But Paul tells us we do not belong to ourselves, but to God. Listen carefully to his words: "What? know ye not that your body is the temple of the Holy Ghost which is in you, which ye have of God, and ye are not your own? For ye are bought with a price." The human family sold itself to Satan, and Christ gave His own life on the cross as the price to buy us back. We belong to God, and hence Paul continues, "Therefore glorify God in your body, and in your spirit, which are God's."

After man had sinned, he was afraid of his Maker, and God could not talk with him as in Eden. So when Israel were chosen to be His people, Moses was commanded to build a tabernacle, in which God promised that He would dwell by His Spirit. It was a very sacred, holy place; and the glory of God overshadowed it in a pillar of cloud by day and in a pillar of fire by night. After Israel reached the promised land, and were through with their wanderings, they built a very beautiful temple for God. When it was dedicated to Him, He showed His approval and acceptance of it as His dwelling place among His people by filling it with a cloud of glory, and sending down fire from heaven to consume the offerings.

The tabernacle and the temple each had two apartments, the holy and the most holy place. What made these buildings holy? — It was the presence of a holy God, who dwelt in them by His Holy Spirit. The Holy Spirit is associated with God and His Son in the great work of salvation. When Christ had nearly finished His work on earth, He promised to send the Holy Spirit, the Comforter, in His place, to guide and comfort His people. "And I will pray the Father, and He shall give you another Comforter, that He may abide with you forever; even the Spirit of truth; whom the world can not receive, because it seeth Him not, neither knoweth Him: but ye know Him; for He dwelleth with you, and shall be in you."

Do you realize that your body is a sacred, holy temple, in which God wishes to dwell by His Holy Spirit? How are you treating this body which God has given you?

This temple differs from all temples built by human hands. It is a living temple, that can move about. The tabernacle made by Moses was wonderful in its structure, but it had to be carried as the people journeyed from place to place. The grand building erected by direction of Solomon was put together without the sound of ax or hammer; yet it was stationary.

Both the tabernacle and the temple were holy, and were kept sacred and clean. Is this living temple holy, sacred, and clean,

and kept thus because of the indwelling of the Holy Spirit of God? If not, He can not accept its service. "If any man defile the temple of God, him shall God destroy; for the temple of God is holy, which temple ye are." We would be very ungrateful if we were not willing to allow our great High Priest to minister in His own temple, which cost such a great price,— His own life.

Questions

1. What does God wish these bodies to be that He has given us? 1 Cor. 6:19; 3:16; 2 Cor. 13:5.
2. What tabernacle and temple were built at God's command? Describe each briefly.
3. Why is the body called a temple? Who built the body temple? 1 Cor. 3:9; Heb. 3:3, 4. Who is to dwell to this temple? 1 Cor. 6:19; 3:16.
4. Does Christ dwell there in person, or through a representative? Who is His representative? John 14:16-18.
5. What made the tabernacle and the temple holy and sacred places?
6. What makes the body a holy, sacred temple?
7. Do our bodies belong to God, or to ourselves? How were they purchased? 1 Cor. 6:19, 20.
8. What does Paul say God will do if we defile the body temple? 1 Cor. 3:17.

Lesson LXXII

The Departments of Service

By reading the record given in the Bible of the service in the tabernacle and in Solomon's temple, we learn that the work was divided among the thousands of Levites who were not less than thirty years of age nor more than fifty. The very best years of life were given to this holy, sacred work. Aaron was made high priest, and had charge of all the service; and his sons were ordained to be priests, and assisted him in the work.

Two of his sons offered strange fire, and died before the Lord; which shows how very particular God was that the service should be performed just as He had directed.

When the tabernacle was built, the Levites were separated into three large divisions; and each division, under a leader, had its particular work to do.

One division, under their "chief," had charge of "the tabernacle, and the tent, the covering thereof, and the hanging for the door of the tabernacle of the congregation, and the hangings of the court, and the curtain for the door of the court, which is by the tabernacle, and by the altar round about, and the cords of it for all the service thereof."

Another company had charge of "the ark, and the table, and the candlestick, and the altars, and the vessels of the sanctuary wherewith they minister, and the hanging, and all the service thereof."

The third division had the care of "the boards of the tabernacle, and the bars thereof, and the pillars thereof, and the sockets thereof, and all the vessels thereof, and all that serveth thereto, and the pillars of the court round about, and their sockets, and their pins, and their cords."

This organization of the tabernacle service shows that God is a God of order, and that everything was planned thoroughly and with perfect system, that there might be no confusion and disorder in the service of the tabernacle.

Now you have sufficient knowledge of the service connected with the tabernacle and the temple, so that we can begin to study the service carried on in the human temple. We have found the service in both the tabernacle and the temple well organized, and the work distributed in a wise way to those who were called upon to serve. While the general organization and plan of service were the same in the tabernacle and the temple, yet there was some difference in the details. This is true because one was a movable building, carried from place to place, while the other was a stationary building.

The human body, built by God, is a still different kind of temple, in that it is a living temple, which can move about without being carried. Its walls, its coverings, its furnishing within and without, are alive, and consist of living material. Yet in this temple there is truly a divine service carried forward daily. We shall find that in many respects the plan and purpose of the human temple are the same as those of the tabernacle of Moses and the temple of Solomon, or very similar. In three respects the tabernacle and the temple were exactly like the human temple:—

1. They were temples of God, in which He dwelt by His Holy Spirit, as He promises to dwell in this body temple.

2. They were holy, as Paul declares our bodies to be.

3. The service carried forward was to restore the image of God in man, physically, mentally, and spiritually. Likewise the service in the human temple is to restore the whole man,— body, soul, and spirit.

In three particulars, the plan of organization and the division of service were similar to the organization and division of service in the human temple:—

1. The high priest had charge of all the service and ministered in the tabernacle and temple. So Christ, our great High Priest, through the Holy Spirit, has charge of all the service and ministers in the human temple.

2. Those who performed the service in the tabernacle and in the temple were organized by the high priest into three divisions, and each was to do the special work assigned for the development of man's threefold nature. In like manner Christ, through His Spirit, organizes a threefold service in the body temple, each differing in character, and all working together to develop man's threefold being.

3. In the tabernacle and temple service, the three large companies of workers were divided into smaller companies, each having a special work to perform. And in the human temple, the three departments — physical, mental, and spiritual — are divided

into smaller departments, each likewise having a special work to perform.

There are seven leading departments of service in the human temple. These are to work harmoniously together under the guidance of the Holy Spirit, according to the laws of service which God has given.

Questions

1. Where in the Bible are the services of the tabernacle and of the temple described?
2. Into how many divisions was the tribe of Levi separated? What did each division do? Num. 3: 17-37.
3. At what age did the Levites serve? Num. 4: 46, 47.
4. What was the difference between the tabernacle service and the temple service? Why this difference?
5. Who had general charge of all the service of the Levites?
6. Compare the service carried on in the human temple with the service of the tabernacle and of the temple.
7. In what three respects are they the same? In what three respects are they similar?
8. Name the three large departments of service in the human temple which correspond to three divisions of man's nature.

Lesson LXXIII

The Information Department

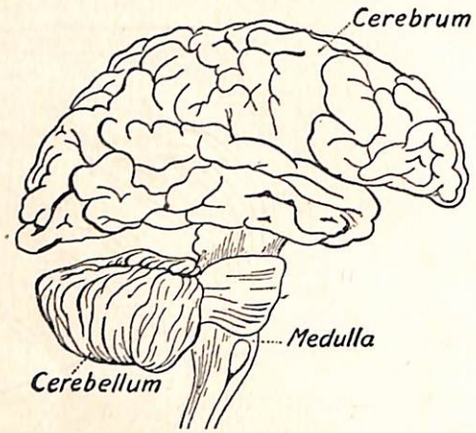
(The Nervous System)

A wise man is strong; yea, a man of knowledge increaseth strength. Prov. 24: 5.

The service rendered by the information department is more important than any other work done in the temple by the various departments of service. Its work is to receive information from the outside world, and to communicate this knowledge to the other departments, so that they will know how to relate themselves properly to each other, and to the conditions that they meet in their work. All the knowledge we gain in life, of whatever kind, is received through the department of information.

We are to use this knowledge for our own good and the good of others.

The system through which the workers receive and give out information is called the nervous system. The nerves have been likened to telegraph wires, and the whole nervous system to a telegraph system, as explained in Book 2, lesson 104.



HUMAN BRAIN

Shown from the side, with the cerebrum and the cerebellum separated from each other

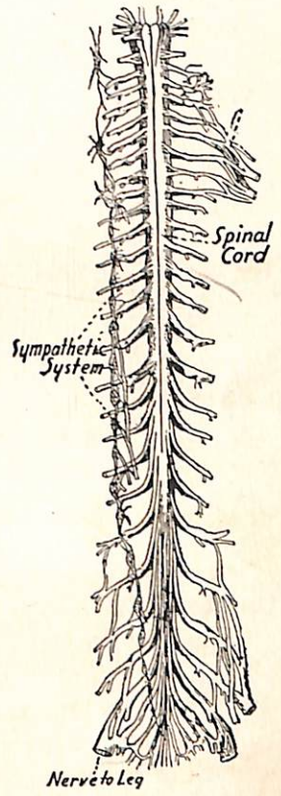
You remember that the main station of the nervous system is located in the cranium, and called the *brain*. The substations are much smaller, and located in different parts of the body. You should refresh your memory as to the structure and lobes of the brain, and also the extentions of the brain downward through the spinal column, and from there to the various organs of the body. It is these extensions that makes it possible to gather information as to how objects appear, how food tastes, how the flowers smell, how the birds sing, and how things feel.

All the sights, tastes, odors, sounds, and feelings are received and recorded in the information department. When the information is received, word is sent to the other departments concerned, and they act as will be best for the entire body. These departments all work together for the good of the whole being. The information department not only informs the other departments, but controls them in a large degree, and thus prevents confusion.

The most mysterious work of the department is not seeing, feeling, hearing, tasting, or smelling; but it is thinking. This is the most wonderful of all the service carried forward in the temple. It takes place nowhere in the body except in the brain,

and the part of the brain that does the thinking is the cerebrum. Thinking is the result of the mind's action; and mind is the result of the power of God acting in the brain, just as motion is the result of the same power acting in the muscles. We do not know how either one is done. They are mysteries too deep for scientists to solve.

When the cerebrum is injured seriously, thinking stops. A general, while giving a command in battle, received a shot in the skull, which caused the bone walls to press on the cerebrum. When the walls were removed, so that the pressure was taken away from the cerebrum, then the general gave the remainder of the command. He could finish the thought that he had partly expressed when he was shot. In persons thus wounded, the brain is sometimes protected by placing a silver plate over the opening made in the skull. On one occasion, a person, without being observed, placed his finger in the opening of another's skull, and pressed on the cerebrum. Immediately the injured man ceased talking. When the finger was removed, the conversation was resumed right at the point where it stopped.



SPINAL CORD

With the spinal nerves attached. Upon one side is shown the sympathetic system.

Scientists have discovered that not only the cerebrum, but also the cerebellum and the medulla, have each their special lines of work to do. Thus we see that the department of information is divided into smaller departments, and each of these looks after one or more lines of work. Let us notice the division of labor in the brain, the main office of the information department:—

1. *The Cerebrum.*— This is the department that does the thinking. In this office, messages are received from the eyes, the ears, the tongue, the nostrils, and the skin. After these messages are received and considered, messages are sent from the cerebrum to one or more departments, telling them what to do.

A few familiar examples will make this plain. Strike suddenly at the eye, and what happens? — The eyelids close to protect the eye, and the hands are raised to aid if necessary. What causes this action of the eyelids and hands? — A message is received in the cerebrum office, from the eye, stating that the eye is in danger and needs assistance. At once a message is sent from that office to the locomotion department, asking that it set in motion the hands and the eyelids to protect the eye; which it does by the action of the muscles of the arms and eyelids.

Touch a hot stove or iron with the hand, and a message is conveyed to the cerebrum office, stating that the hand is burned. A message from there to the locomotion department results in the muscles of the arm acting at once to pull the hand away from the place of danger. A train, a street car, or an automobile is seen coming swiftly toward us, and immediately we run to a place of safety. The eyes behold the danger, and send a message to the central office for assistance. A message sent from the central office to the locomotion department results in the feet being set in motion, and we are borne away as fast as they will carry us. How important the work in this central office! The workers there are never off duty, and they carry very grave responsibilities. Many times a message requires wise decision and immediate action to save and protect an organ of the body.

From the above examples, we see that the cerebrum not only reasons and decides, but it controls the voluntary muscles in the locomotion department. These are the muscles that act only when called upon by the cerebrum to do so. The involuntary muscles, those that act without our thinking, are under the direction of another division of workers in the information department.

2. *The Cerebellum.*— This is another part of the brain, located below the cerebrum, and not nearly so large. It acts with the cerebrum to make its work more effective. It helps the muscles in carrying out fully the orders received from the cerebrum. If several muscles are to act, it helps them to act in proper order and at the right time. Without the aid of the cerebrum, the arm will not guide the hammer to hit the nail on the head every time; and a man will walk in a staggering way.

3. *The Medulla Oblongata.*— It is situated below the cerebellum, and is the smallest division of the brain. The work of this division is to look after those departments of service that have most to do with sustaining life in the body — the circulatory and respiratory departments. It regulates the beating of the heart, and the breathing of the lungs, and other less important matters.

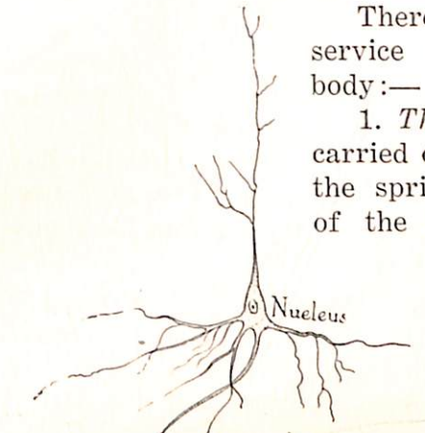
4. *The Spinal Cord.*— The spinal cord is not a part of the brain, but is an extension of it below the medulla, reaching the whole length of the spinal column. Branches of this cord, called nerves, pass out between the vertebræ to all parts of the body. Thus, you see, the nerves from all portions of the body are brought together in the spinal column just before leading up into the brain. This is similar to the telegraph and telephone wires coming in from the country districts and uniting before leading into the central office. There are thirty-one pairs of nerves that pass into the spinal column, twenty-four pairs between the vertebræ, and seven through holes in the *sacrum* — the lower end of the backbone. Twelve pairs of nerves pass into the brain, not through the spinal column, but through openings in the skull. Where some of the nerves cross each other, or there is a grouping together of nerve cells, we have what is called a *ganglion*. If to one or more ganglia a special work is given, as controlling the breathing, or the beating of the heart, then we have what is called a *nerve center*. The brain consists of a large number of nerve centers with the connecting nerve fibers.

The work done by the information department through the nervous system is certainly wonderful, and testifies to the wisdom and skill of the Master Temple Builder. But let us study a little more closely the structure of the nervous system. You have already learned that all living substances, plant or animal, are composed of small bodies called cells. The nervous system is composed of nerve cells varying greatly in size and shape. These cells have many branches extending out in all directions, but one long branch which may extend from the brain or the spinal column to a muscle or skin cell several inches or even several feet away. These long threads are called *nerve fibers*. The nerve fibers reach from the brain to the ends of the fingers, and from the end of the spinal cord to the toes. They might be compared in structure to a lead pencil. The part of the fiber that carries the message is in the center, and corresponds to the lead in the pencil. It is called the *axis cylinder*. Outside of this is the *medullary sheath,* which strengthens the fiber, just as the wood of a lead pencil strengthens the lead. Outside of this is the *primitive sheath,* which corresponds to the coat of paint surrounding the wood. We find that the brain and the spinal cord are made up of white and gray matter. The white matter is on the outside of the spinal cord, and the gray matter on the inside. With the brain, the arrangement is just the opposite; the gray matter is on the outside, and the white matter on the inside.

Nerve cells, as to their work, are divided into two classes:—

1. *Sensory Cells.*— These are the cells that are active in the use of the five senses. They carry messages to the brain, and receive them in the information department. The sensory cells through which the messages are carried form fibers called *sensory fibers.*

2. *Motor Cells.*— These are cells that carry messages from the information department to the other departments. They form the fibers over which the messages are sent, and are called *motor fibers.*



NERVE CELL AND FIBER

There are two principal divisions of service in the nervous system of the body:—

1. *The Voluntary Service.*— This is carried on by the will and the intelligence, the spring of action being the cerebrum of the brain. It includes all our conscious acts, and even some that are so much of a habit that we do not have to think to perform them, such as walking, eating, etc.

2. *The Involuntary Service.*— This is the most wonderful of all the service performed in the temple. It is carried forward without our thought or will, the springs of action being from the ganglia, or knots, one row on each side of the spinal column. From these knots, nerves go to the lungs, the heart, the stomach, and other vital organs, and control them without bothering the brain. These are called *sympathetic nerves,* because they work together in close sympathy. If they find the stomach is overloaded, they cause the heart to beat faster and send it more blood. This sympathy is necessary, and makes provision for a diseased organ to rest until it can recover its strength. If "one member suffer, all the members suffer with it." However, if any of these vital organs get into serious difficulty, then word is sent to information department headquarters for help.

But the usual work of all these vital organs is carried forward without any thought on our part. The heart beats, the lungs breathe, the food digests, and we are not aware of it unless some difficulty arises from mistreatment of these tireless workers.

The Creator has so arranged the nervous system, that whether we are awake or asleep, the heart, the lungs, and the stomach still carry forward their work of perpetuating life. If you want to see how much you control these vital organs, try to stop your heart from beating, your lungs from breathing, and your food from digesting. This is a very wise and wonderful arrangement for this important service of the temple.

You have already studied the special organs of sensation — the gateways of knowledge to the information department office; but let us consider them a little further, for there is much of value to learn about their service.

General Sensations.— The nerves of general sensation are not found in special organs, but are more generally distributed throughout the body. The general sensations give information as to the condition of the interior of the body, while the special sensations tell the condition of the body on the outside, and also the conditions in the world about us. The information given by the general senses is not quite so exact and definite as that given by the special senses.

The sympathetic nerves usually produce the general sensations, and the spinal and cranial nerves usually produce the special sensations. The following are some of the more common general sensations: hunger, thirst, nausea, faintness, giddiness, weight, sleepiness, pain, and fatigue. All these sensations are a great blessing to us, for without them we could not live. Pain, which is so much dreaded, is our best friend, and its danger signals should be carefully heeded. We should not try to deaden it by the use of drugs.

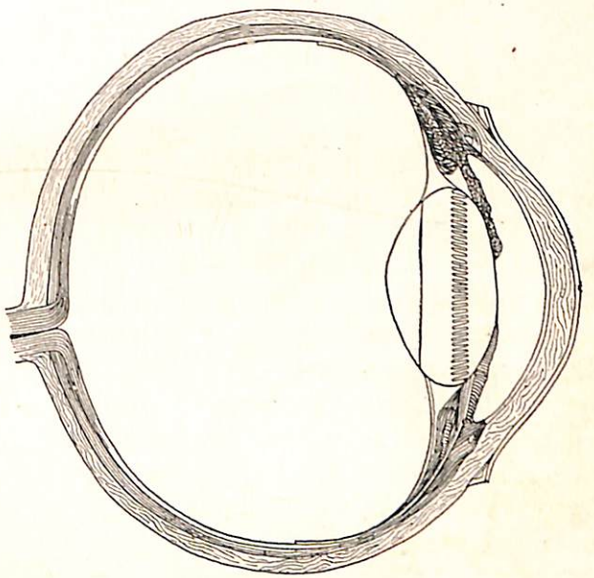
The Special Senses.— We are familiar with the organs of the five special senses,— the eyes, the ears, the nostrils, the tongue, and the skin,— and the special sensations received by them,— sight, sound, smell, taste, and touch.

Physiologists tell us that there is a sixth special sense, the sense of temperature. This sense of heat and cold is very necessary in order to protect the body, which must have an

even temperature to be kept in health. The temperature is determined by the thermic nerves, which end in the skin, the mouth, the pharynx, the larynx, the esophagus, and the nostrils. Why are they placed there?

These special senses you have already studied, but should review them in Book 2. We want to study them further in this lesson, as there are many wonderful and valuable things to learn, which will help us to appreciate the organs of sense more and use them more carefully.

The Eyes.— These globelike bodies, fitted into round sockets in the forehead, are certainly wonderfully made. Let us study their structure. They are both alike; but having two of them, we can see with larger and better vision. At the back of the eye is a soft cushion of fat that allows the eye to sink into it when pressed, and thus it is protected at the rear as well as at the sides. In front, it is protected by the eyelids and the eyelashes. The eyeball has a wall consisting of three layers, or coats. The first coat is composed of dense, hard tissues, and for this reason is called the *sclerotic coat.* It is the one that gives firmness to the eye. This coat is visible, and can be seen between the eyelids, being known as the "white of the eye." No light can pass through the sclerotic coat, except where it bulges out and forms the transparent part called the *cornea.*



CROSS SECTION OF EYE

This portion is best seen by looking sidewise at the eye of another person.

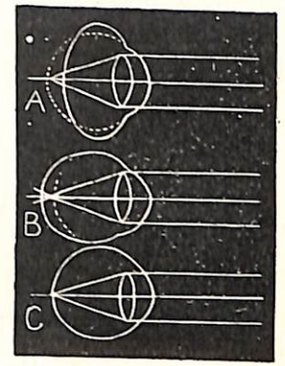
The second coat of the wall, called the *choroid,* is of a dark color instead of white, and thus absorbs the light. The sclerotic coat separates from the choroid, near the front of the eye, and forms the *iris,* which gives the color to the eyes, and also helps to regulate the amount of light received by them. The round opening in the eye is called the *pupil.*

The third coat, called the *retina,* is the most important, for it is made up of the nerve fibers of the optic nerve, which carries to the brain the sensations of light that we call sight. There are millions of fibers in the optic nerve, and these spread out in a thin coat, forming the retina.

Inside these three coats, like the soft, juicy pulp and fluid within the orange rind, are three more or less soft divisions of substance. The first is a watery fluid just inside the cornea, called the *aqueous humor.* The larger portion of the eye cavity is filled with a jellylike substance called the *vitreous humor.* Between the aqueous and the vitreous humor, just back of the iris, is the third substance, shaped like a magnifying lens. This is called the *crystalline lens,* and is the most wonderful lens ever made. It is a living lens, and attached to it are muscles that can change its form to suit the eye in observing things near or far off. You already know, from your study of the hand lens, that the purpose of a lens is to gather rays of light and focus them at a single point. This the crystalline lens does, focusing the rays on the retina, forming on it images of objects. These images are carried by the optic nerve to the brain; and this is how we see. This wonderful mechanism was made by Him who sees all things. "All things are naked and opened unto the eyes of Him with whom we have to do."

We should be very careful how we use our eyes. Some people have defective eyes, and it is necessary to place artificial lenses, called *eyeglasses,* or *spectacles,* before their eyes, so that the light will be focused on the retina. In these cases, the

living lens, for some reason, is out of shape, and the light is focused before it reaches the retina, causing nearsightedness; or beyond the retina, causing farsightedness. What kind of lenses should be used for nearsightedness? For farsightedness? The normal lens will focus the rays on the retina. These three kinds of sight are illustrated in the accompanying diagram.



CONVERGING OF LIGHT RAYS ON THE RETINA

A, Farsightedness
B, Nearsightedness
C, Normal sight

If you have good eyes, and would keep them so,—

1. Do not overwork them, but give them opportunity to rest occasionally, especially if you are reading, or doing fine, close work. This can be done by looking away occasionally to distant objects.

2. Do not use your eyes after they are tired and begin to smart or ache.

3. Do not read, or do fine, close work, during twilight.

4. Do not work or read with a light in front of you, or in the glare of any light.

5. Do not read books, papers, or magazines printed in fine type.

6. Do not read when you are ill or getting well.

7. Do not read or work with bent head if you can avoid it.

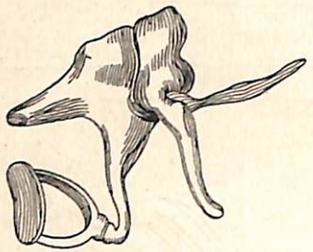
8. Do not read when your eyes are sore.

9. Do not read in a dry, stove-heated atmosphere, for it will dry the eyeballs and cause a smarting sensation.

10. Do not read by a lamp which has no shade.

There are many more wonderful things to learn about the eyes, but we shall mention only the movements of the eyes. There are several pairs of muscles that move each eye about in its bed of fat, and this arrangement makes it unnecessary to move the head for every change of direction of the objects about us. Both eyes move at the same time and in the same direction. Three pairs of the cranial nerves control the muscles of the

eyes. I wonder if we have our eyes under good control, so that they see all that they should see, and refrain from seeing the things they should not see. Isaiah, speaking of the individual who shall dwell in the glorious presence of God, says that it is not only "he that walketh righteously, and speaketh uprightly," but also he that "shutteth his eyes from seeing evil." David prayed for power to control his eyes. "Turn away mine eyes from beholding vanity; and quicken Thou me in Thy way." Do you have trouble in controlling your eyes? They may not be quite so hard to control as the tongue; but we shall have to allow the Spirit of God to dwell in us, that it may control them as they minister in the temple.



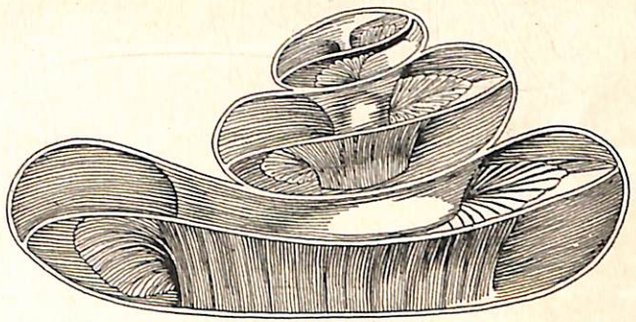
THREE BONES OF THE EAR

The Ears.— These organs carry on a very important ministry in the body, and they are wonderfully constructed. The ear is divided into three chambers, called the *external ear,* the *middle ear,* and the *inner ear.* The cranial nerves carrying the messages from the ear to the brain are called *auditory nerves,* which means *hearing nerves.* The external ear is the visible portion, and contains the canal leading to the middle ear. However, the canal does not open into the middle ear, but is closed by a skin membrane, which is necessary to produce sound, sometimes called the *drumskin,* but the scientific name is *tympanum.* You can not see the tympanum, as the canal is curved. This is a wise provision against flying particles or insects which might otherwise strike directly against this very delicate drumhead.

The middle ear is an air chamber. How does the air get into this chamber? — It passes from the pharynx through what is called the *Eustachian tube* into the middle ear. The tube opens and allows the air to pass through it every time we swallow, and in this way the pressure of the air on both sides of the eardrum is kept equal. In the middle ear are three small bones

that, like a telephone wire, carry the sound into the inner ear. The bone next to the eardrum is called the *malleus,* or *hammer;* that next to it, the *incus,* or *anvil;* and the bone connecting with the inner ear is termed the *stapes,* or *stirrup.* The Latin names mean the same as the English names following them.

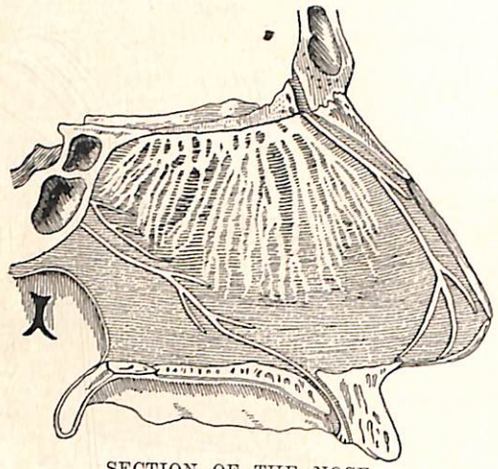
The inner ear is called the *labyrinth,* because it has numerous winding passages. The spiral passages are known as the *snail shell;* and three passages not so winding are called *loops.* What is the office of the inner ear? — It is the place where the sound vibrations are gathered up by the ends of the auditory nerves and sent on to the information department headquarters. How is this done? — The inner ear contains a liquid, which is set in vibration by the movement of the stirrup bone against the wall of the middle ear. This vibration of the liquid excites the nerve fibers in the wall of the labyrinth. There are thousands of rods connected with the ends of the nerve fibers, and it is supposed that only those are set in motion which agree with the pitch of the sound received by the ear. The ear is a marvelous harp, whose strings catch up all the sounds in nature, and carry them into the great music hall, where they are reproduced for our happiness and comfort.



SNAIL CHAMBER OF THE EAR

I wonder if we appreciate this remarkable instrument, and take care of it as we ought. The same God who made the eye, made the ear. "He that planted the ear, shall He not hear?" He not only sees us, but hears us; and may the things He sees us do and hears us say give Him pleasure and not pain.

Have we learned to control our ears? or do ye have trouble with them, as well as with our eyes? Christ gave His disciples this warning: "Take heed what ye hear;" and again, "Take heed how ye hear." How much trouble comes into this world because we allow our ears to hear things they ought not to hear! Sometimes things we should hear, we do not hear aright, and misunderstandings are the result. We must have the Spirit of God to help us to use our ears aright, that their ministry in His temple may be to His honor and glory.

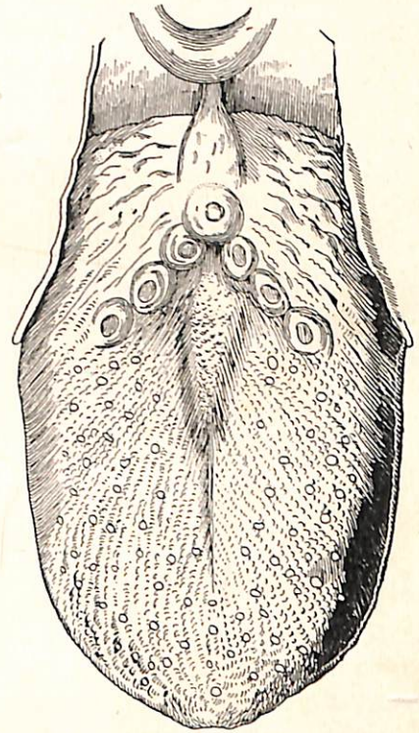


SECTION OF THE NOSE

The external ear should be cleansed frequently, as the many creases in it hold the dirt. The canal should be rinsed with warm water, and no instrument should be used for removing ear-wax or any foreign body from it. What can not be removed by using sweet oil and rinsing with water from a syringe, should be left to a surgeon to look after. Never should a person strike or shout into another's ears, for the ears are too delicate instruments to be treated rudely, and are very difficult to repair. Deafness often results because of careless or harsh treatment. Where the inner ear is not injured, some instrument is used that will cause the liquid in the labyrinth to vibrate, and hearing is partially restored. The dentiphone is an instrument taken between the teeth, and the sound vibrations are conducted through the teeth and the bones to the liquid in the labyrinth. Place a running watch between the lips, and then between the teeth, and note the difference in the loudness of the ticks.

The Nostrils.— In the nostrils, we find the nerves of smell, called the *olfactory nerves.* The nerve fibers end in the mucous membrane in the upper half of the two nasal chambers. Some people live so carelessly that they are almost continuously suffering of colds, and the colds bring on catarrh. The influence of colds and catarrh is to weaken or destroy the smelling powers, and then delightful odors are not appreciated. The faithful sentinel whose work is to warn us of hurtful foods and gases is sacrificed on account of our careless habits of living.

The Tongue.— In this organ is lodged another important sense,— that of taste. Smell and taste are very closely related, and might be considered twin sisters. Sometimes what we call *tastes* are really smells, and what we call *smells* are really tastes. When you have a severe cold in the head, food does not taste so appetizing. Why?



UPPER SURFACE OF THE TONGUE

The sense of taste is produced by cranial nerves that pass to the tongue. The nerve fibers end in the papillæ found on its surface, which are d i v i d e d into three classes, as follows:—

1. Threadlike Papillæ. These are found on the sides and tip of the tongue, but are thought to be used mostly for feeling rather than for tasting.

2. Mushroom Papillæ. These are similar to the threadlike papillæ, but larger, and scattered among them. Their form suggested the name.

3. Walled Papillæ. These are only eight or ten in number, and form a V-shaped outline with the point toward the throat. They receive their name from the wall of mucous membrane that surrounds each papilla.

There are four principal tastes,— sour and sweet, saline (salty) and bitter. Sour and sweet are recognized on the edges of the tongue; saline and bitter at the back of the tongue. Prove this by trial.

When the sense of taste is so weakened that one can not detect and enjoy delicate flavors, then he wants the food to have a more decided flavor, else it seems insipid. Spices, salt, and sugar must be added in such quantities that the natural flavor God gave to the food is almost or entirely lacking. This is the only way to satisfy the degenerated appetite. We should learn to enjoy the flavors that are naturally in the foods we eat, for they are the best for health. Bad cooks have perhaps done more to spoil our sense of taste than has any other one thing. When properly prepared, grains and other foods have each its own delicate, pleasant flavor.

Ever since Eve tasted the forbidden fruit in Eden, man has had to battle against perverted appetite. The ministry of the nostrils in smelling and of the tongue in tasting must be under the control of the Spirit of God, or their service will not be for the good of man nor to the glory of God. Let us frequently taste of the good word of God, and it will help us to control not only our appetites but also all our other inclinations.

— *The Skin.*— In the skin we find a sense called *touch,* or *feeling.* The sense of touch is developed all over the surface of the body, so that it can recognize the contact of any outside object, and thus instantly defend itself. The parts of the body that have the keenest sense of touch are the forehead and the temples. Why is this the case, do you think? The tip of the tongue and the lips are very sensitive to touch. The ends of the fingers also have this sense more highly developed than has the rest of the

hand. Can you tell why this is so? Think how unfortunate one would be if he were deprived of this sense; but that is what happens when the body suffers from a stroke of paralysis. We know how unpleasant the sensation is when the foot or the arm "goes to sleep," as we say. This is a partial paralysis, caused by lessening the circulation of the blood in that part of the body.

The sense of touch is produced by nerves that end in the papillæ of the skin. They form circular ridges that can be seen plainly on the end of the fingers. The papillæ are less abundant in the middle of the back, therefore the sense of touch is dull there. The small nerve fibers from the papillæ all unite to form nerves that lead back to the main office of the department of information.

You see that the complete record of all our sensations, general and special, is kept by the information department at its main office, the brain. All the sense organs carry on their work for the good of the body. If we appreciate the service they render, we will treat them with consideration.

It is through the brain, the holiest and most sacred department of the living temple, that the Holy Spirit communicates with us. If we have tired, weakened, exhausted brain and nerves, how much can the Holy Spirit impress us?

It is in this department that the character is formed. Character is made up of the habits of life. Habits are the result of thinking, and then doing over and over the things we have thought. But thinking, you remember, is the action of the mind, and takes place in the cerebrum of the brain. And mind is the result of God's power acting on the brain. This power acts on the brain of a wicked person as well as that of a good person, and he thinks and reasons and wills with the mind God has given him. What then makes the difference between a good man and a wicked man? — It is just this: One allows the Spirit of God to dwell in his body temple, to guide and control his mind. As Paul says, "It is God which worketh in you both to will and to do of His good pleasure." The other will not allow

the Holy Spirit to dwell in his body temple; and his mind is under the control of Satan and evil spirits.

The cells of the brain form and grow according to our thoughts and habits, and that is the reason habits become so fixed and hard to change after once formed. This is just as true of a good habit as of a bad one. If we change our habits, good or bad, new brain cells have to be formed, and the old ones weakened and destroyed by disuse. Let us allow the Spirit of God to control our minds, that we may form good habits, which lengthen life and insure peace. "For to be carnally [fleshly] minded is death; but to be spiritually minded is life and peace."

Questions

1. What department of the human temple is taken up in this study? What is the work of this department?
2. How is the information thus gathered, to be used? What will knowledge do for its possessor? Prov. 24: 5.
3. Through what organized system is the information gained? To what may this system be compared?
4. Where is the central office of the information department located? What are the advantages of this location?
5. Name the divisions of the brain. What division of labor is found in the brain?
6. Describe the message service that centers in the cerebrum. Illustrate the service from common examples in life.
7. What is the work of the cerebellum? The medulla oblongata? The spinal cord?
8. Give a description of the voluntary and the involuntary service carried on by the nervous system.
9. Explain the structure of the nervous system by describing the nerve cells, the nerve fibers, and the ganglia.
10. How are sensations classified? Give examples of each.
11. Describe the structure of the eye and the ear. What difficulty is experienced in controlling them? Ps. 119: 37; Isa. 33: 15. Describe defective eyes and ears, and tell how they may be assisted.
12. To what department in the tabernacle of Moses and the temple of Solomon may the information department of the body be compared? In what respects are they similar?

13. What is the relation of thought to habit? Of habit to character? Rom. 8: 6.
14. How only may a righteous character be formed? Phil. 2: 13.

Note Book Requirements

1. Index with letters, and name, the parts shown in the section of the eye on page 94.
2. On the same page, describe the diagram showing defective and normal eyesight.
3. On pages 104 and 105 write a composition on the subject "How We Know Things."

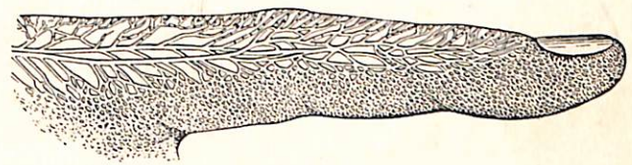
Lesson LXXIV

Circulation Department

(The Circulatory System)

But flesh with the life thereof, which is the blood thereof, shall ye not eat. Gen. 9: 4.

The department of circulation has to do largely with the distribution of heat and food throughout the body. With this department you are already more or less familiar, as it is concerned principally with the circulation of the blood. It also has to do with the circulation of a substance called *lymph*. This is the same as the blood, without the red corpuscles. You have seen it many times, but did not know what it was. If the skin has been grazed, but not enough to draw the blood, a watery liquid will ooze from the skin. You know what blisters are, and perhaps have had them on your hands. There are two kinds of blisters, usually called *water blisters* and *blood blisters*. The first are



LYMPH VESSELS OF THE FINGER

filled with lymph, and the second with blood. The lymph comes nearer the surface of the skin than the blood; but both circulate throughout the body. They are coworkers, like the senses of taste and smell, and like the cerebrum and cerebellum of the brain. Quite often we find the workers in the human temple yoked up together in their work, which makes it more effective and easier to accomplish than to work single-handed.

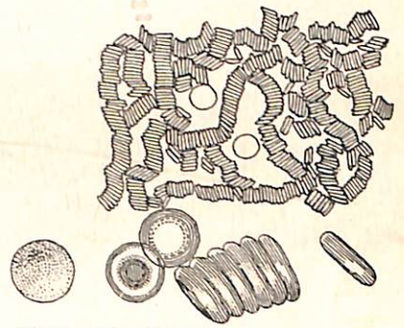
In Book 2, lesson 97, you learned something of the service performed in the circulation department. It would be well to review this lesson, so as to have fresh in mind the facts there given.

We have become acquainted with the heart, the strong pump that forces the blood through the arteries into the capillaries. We have learned that the blood is returned to the heart by means of veins, and that after making this circuit, it is sent into the lungs to be purified. On being returned to the heart, it is sent out again to warm the body and to provide all its tissues with a fresh supply of food, and carry away the gaseous waste — carbon dioxide.

The blood, when looked at through a microscope, seems to be composed of a watery fluid in which are found floating millions of small, round, red, disk-shaped cells called *red corpuscles.* Here and there, scattered among these, are larger, white corpuscles. The watery portion of the blood is called *plasma;* the red and the white corpuscles are blood cells. Each part of the blood has its work to do. The plasma is the stream that transports the blood corpuscles. The white corpuscles seem to be alive, and appear and act very much like the amœbas studied in a previous lesson. It has been discovered that these white cells protect the red ones by destroying disease germs that get into the blood, also by destroying poisonous substances that get into the blood and into the tissues of the body. They are not confined to the arteries and the capillaries, like the red corpuscles. They can go through the walls of these ducts, and not leave any hole behind them. In a healthy body, there is one

white corpuscle to about every five hundred red corpuscles. Some persons have but very few or no white corpuscles in the blood. They are an easy prey to disease germs, for they have no soldier corpuscles to protect them.

As the amœba lives in the water, so the blood cells live in the watery plasma, which not only carries the blood corpuscles, but also carries, in very small particles, the food that has been eaten and digested. How do the food particles find their way to the tissues of the body to build them up, since the blood carrying the food and the oxygen is in the arteries and the capillaries? — This is accomplished by the second division of the circulatory system, called the *lymphatic system.* The lymph, already described, is the plasma of the blood which has worked its way through the thin walls of the capillaries, carrying the food particles with it. What is the service performed by the lymph? — It is the watery fluid that bathes all the tissues of the body, coming in contact with all the cells, and filling all the spaces in the tissues. Now the arteries and the capillaries do not come in contact with all the cells in the various tissues. They might be compared to the main line and branches of a railroad as they traverse a country. Some of the people live in small towns or country districts away from the railroad, and other means of transportation must be provided to take to them their food and fuel. The arteries and the capillaries carry the food and the fuel to the nearest station. From this point it is transported by the lymph to the hungry cells.



RED AND WHITE CORPUSCLES
(GREATLY MAGNIFIED)

The food can pass through the thin walls of the capillaries. The red corpuscles are not able to do this; but the oxygen they carry, being a gas, passes through the walls without difficulty, and carbon dioxide is formed, which is carried to the heart

by the veins. From the heart, it is transferred to the lungs, and exhaled into the air. Oxygen is inhaled at the next breath, and in this way the transfers of food, oxygen, and carbon dioxide are made. This plan of service in the temple shows great skill, and is another evidence that the temple is "fearfully and wonderfully made."

Let us now study a little more fully the structure and operations of these two divisions of the circulatory system, with their ducts, tubes, vessels, engine, etc.

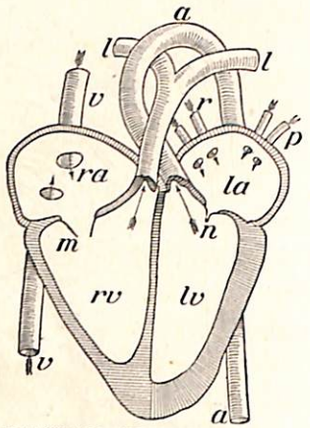


DIAGRAM SHOWING FRONT HALF OF HEART CUT AWAY

a, aorta; *l*, arteries to the lungs; *la*, left auricle; *lv*, left ventricle; *m*, tricuspid valve open; *n*, bicuspid or mitral valve closed; *p* and *r*, veins from the lungs; *ra*, right auricle; *rv*, right ventricle; *v*, vena cava. Arrows show direction of circulation.

I. *The Blood System.*— The blood system of circulation is divided into two parts:—

a. The Pulmonary Circulation.— This includes the blood vessels that conduct the blood from the heart to and through the lungs, and back to the heart.

b. The Systemic Circulation.— This includes the blood vessels that conduct the blood from the heart to and through the other organs of the body, and back to the heart.

Thus we see that the center of all blood circulation, and the starting point of both the pulmonary and the systemic division, is the heart. This is a tireless worker, and forces the blood through the arteries and capillaries to all parts of the body. Where is the heart located in the body? King Solomon said, "A wise man's heart is at his right hand; but a fool's heart at his left." He could not have had reference to the organ that controls the blood, for it would then change its position when a foolish man becomes a wise man. In the Bible, the word "heart" often means the mind or affections. It was believed at one time that the mind and the affections were seated in the heart. The

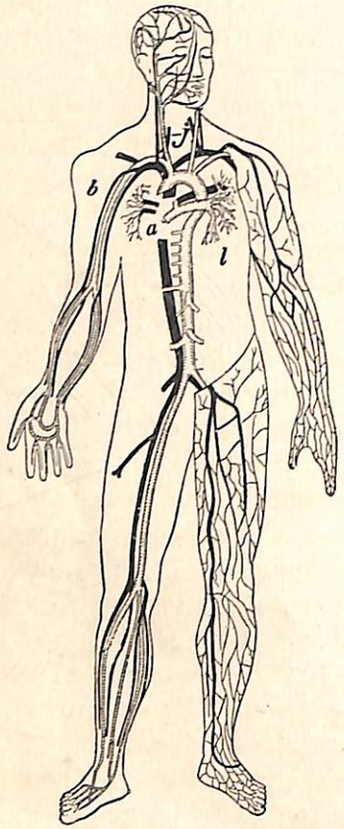
reason for thinking so was because the feelings of the mind, as happiness and gloominess, hope and fear, cause the heart to beat lightly or heavily. But the meaning of the wise man's words is that the wise man's mind is on the right side of every question, while the fool's mind is on the wrong side. Now as to the location of the heart organ, it is really not on either side, but very nearly in the middle of the trunk of the body, under the breastbone. It lies in an inclined position, with the smaller end of the cone-shaped form on the left side. This end taps the chest wall between the fifth and the sixth rib, and at this point you can feel the heartbeats most plainly.

The heart is a living double pump. Each pump has two chambers, an auricle and a ventricle, with a valve between them. The valves are cuplike pockets in the openings between the chambers. These press against the wall when the blood flows in one direction, but fill when the blood starts in the opposite direction. This is illustrated by an umbrella, which remains closed when pointed against the wind, but when turned the other way it opens up and blocks the passage of the wind. Thus these valves allow the blood to flow freely in one direction, but block the way when it begins to flow in the opposite direction. You are acquainted with the construction of a water pump. It lifts the water, and contains valves that will not allow the water to flow back.

The heart pumps are operated by its strong muscles. In fact the heart walls are nearly all composed of muscle. These muscles are controlled by two pairs of nerves that come from the information department. One pair come from the sympathetic nerve system, which you will remember takes charge of the vital organs, without the aid of the brain. However, one pair, called the *vagus nerves,* come directly from the brain, and slow down the heart when it gets to beating too fast.

The two pumps of the heart are entirely separate. One receives the impure blood from the body by means of veins and capillaries, and sends it up to the lungs, to be purified. The

other pump receives the purified blood from the lungs, and sends it, by means of arteries and capillaries, through the whole body.



CHIEF BLOOD VESSELS OF THE HUMAN BODY

On the left arm and leg the vessels are shown as they appear just beneath the skin. The veins are in black. *a*, location of the heart; *b*, artery and veins; *j*, jugular vein; *l*, pulmonary vessels to the lungs.

Let us follow the circuit of the blood through the two systems. In the pulmonary (lung) system of circulation, the impure blood just returned from the body is found in the right auricle. From this chamber it passes through the *tricuspid* (three-pointed) *valve* into the right ventricle below. The blood is forced from this chamber through the *semilunar* (half-moon shaped) *valves* into the *pulmonary artery* and on into the lungs. The blood is purified while passing through the capillaries of the lungs, and then it is conducted back to the left auricle through the four *pulmonary veins.* From this chamber it passes through the *bicuspid* (two-pointed) or *mitral valve* into the left ventricle. This is the fourth and last chamber of the heart entered by the blood; and from this it is forced through the large artery, the *aorta,* to all parts of the system. The right and the left auricle are receiving chambers, and therefore they do not have thick walls like the ventricles. The walls of the left ventricle are much thicker and stronger than those of the right ventricle, as it sends the blood throughout the body, the other only to the lungs. The circulation of the blood through the entire system, from the time it enters the aorta till it returns to the heart, is called the *systemic circulation.*

The blood flows through the aorta and its branches to all the organs of the body, to supply them with oxygen. The first two arteries that branch off from the aorta pass into the heart, and provide its muscles and tissues with the oxygen they need. It seems strange that special arteries should supply the heart with blood, when the great stream of blood flows through it constantly. It is like the tree. The sap going up the trunk to its branches, leaves, flowers, and fruit, does not nourish the bark, but special ducts provide it with sap.

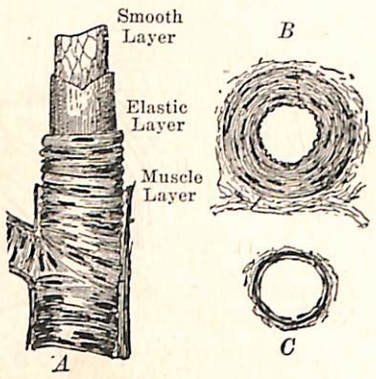
The next two arteries branch off from the aorta about two inches above the heart, just before it turns to go downward to the lower organs. These two arteries pass up the neck into the head, one on each side. They are called the *carotids.* Feel their pulsations with the fingers placed on both sides of the trachea, or windpipe. Close to the carotids are two *subclavian arteries,* one passing into each arm.

The aorta passes down through the abdomen, and gives off side branches to the stomach, the intestines, and the other organs in the abdomen. Then it divides into two branches, one going down each leg. Each of the arteries described, divides into smaller and smaller branches, and the smallest twigs divide into vessels called *capillaries,* too small to be seen with the naked eye.

Now what becomes of the blood so thoroughly distributed throughout the tissues of the body? — Laden with waste material, principally carbon dioxide, it flows into minute veins, and thence into those of greater size, until it reaches two large veins that carry it back to the heart. The blood from the head comes down in the two large *jugular veins,* and these unite with a vein from each arm. Finally all four join to form one very large vein, the *superior vena cava,* which enters directly into the top of the right auricle,— the place where we began to trace the blood in its winding journey. A larger vein, called the *inferior vena cava,* empties the impure blood collected from the lower part of the body into the side of the right auricle.

We have found that the blood is purified in the lungs; but there are two other blood refineries. One is the liver, and the other is the kidneys. The purified blood from these organs is carried by the large veins to the heart.

This is the general plan for distributing, collecting, and purifying the blood. This process is constantly repeated in the body as long as there is life. Having studied the general system, let us now examine the structure of the pipes that conduct the blood.



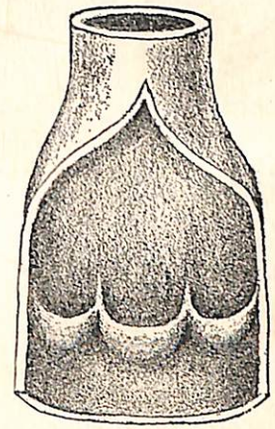
STRUCTURE OF A BLOOD VESSEL

At *A* is shown an artery with the different layers removed at different levels. At *B* is a cross section of an artery, and at *C* of a vein.

1. *The Arteries.*— These have three layers, or coats. The outer coat is *elastic;* the middle coat is *muscular;* and the inner coat is *smooth.* Notice that this kind of tube is well adapted to the service it renders. The arteries are always full of blood. The heart beats steadily away, forcing the blood on through the arteries and the capillaries. Sometimes the blood in the smaller tubes moves slowly, and can not get out of the way for the new supply that the muscles of the left ventricle are urging on. But the outer coating of the arteries being elastic, the tube will increase in size, like a rubber hose, under pressure, and thus take care of the blood until it can flow on at its regular rate.

The beating or pulsating of the heart is called the *pulse.* In men, the rate of the pulse is about seventy a minute; in women, about eighty a minute. It differs in the same individuals at different times, as it depends on the position and activity of the body. The pulse is slowest when we are lying down, and it gradually increases as we sit, stand, and run. Why does it increase?

Now let us consider the *muscular coat* of the arteries, and learn its value. The amount of blood in the body remains the same; and this amount, with average-sized grown persons, is about five quarts. The blood supplies food to the body; and when the organs are active, they need an additional supply of blood, to bring more food to nourish them. But the entire blood supply can not suddenly be increased; therefore the Creator has provided the arteries with a muscular coat that can expand and cause more blood to flow to a certain organ hard at work. With an organ at rest, the arteries conveying the blood contract, and furnish a less supply. You have noticed that it is difficult to study immediately after a meal. The blood from the brain had gone to the assistance of the stomach. It is equally difficult, and for the same reason, for the stomach to digest food while the brain is hard at study or worrying. Hence our minds should be free from care at mealtime. You now see how necessary is the muscular coat of the arteries. If all the organs of the body need a greater supply of blood at the same time, the emergency is met by the heart beating faster and stronger, thus supplying fresh blood more rapidly.



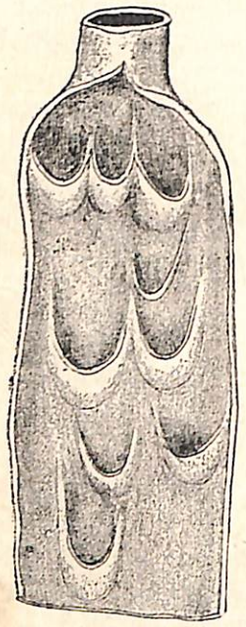
PULMONARY ARTERY CUT OPEN TO SHOW THE SEMILUNAR VALVES

The inner coat of an artery is smooth on the inside, to prevent friction, and thus not retard the blood. If it were rough, the heart would have to work harder. When we reach the capillaries, we find the two outer coats are lacking, for they are not needed there.

2. *The Capillaries.*— These are very short and thin, and thus friction is reduced to the smallest degree. They are exceedingly numerous, in order that all the tissues may be reached, and the flow of blood be slow enough to leave all the food needed, and at the same time gather up the wastes that have accumulated. The capillary walls are

so thin that the waste materials pass readily through them into the blood. The flow of the blood through the capillaries is much slower than through the arteries and veins.

In the large arteries near the heart, the flow is about one foot a second; but as they divide into smaller channels, the rate decreases, until in the capillaries it is about one fiftieth of an inch a second. After the blood passes into the veins, the flow gradually increases until it reaches the heart, the rate then being about the same as when the blood leaves the heart.



VEIN CUT OPEN TO SHOW IRREGULAR VALVES WITHIN

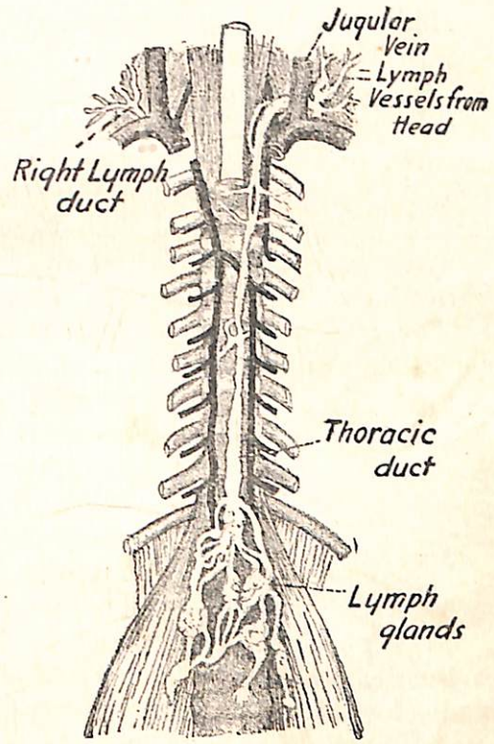
3. *The Veins.*— These are made of the same tissues as the arteries; but the walls are so much thinner that the tube collapses when empty. The elastic and the muscular coat are mixed together. The veins are much less elastic and rigid, but have a very smooth inner coat, which is lined with pockets similar to the valves in the pulmonary artery. When the blood flows toward the heart, these pockets are pressed against the wall of the veins, and offer very little resistance to the flow; but if the blood starts backward, these pockets fill, and occupy the whole vein, thus stopping the backward movement.

You can prove this by experimenting with the large veins on the wrists of a grown person. If you place the middle finger on one of these veins, and stroke it with the forefinger toward the elbow, which is toward the heart, what takes place? — The vein remains empty. Why? — Because the pocket valves hold the blood from going back. Now stroke this vein toward the hand, and notice how the vein swells up into knots where the pockets are. When a boy pushes his hands into his pockets, the pockets swell out; but when he rubs in the opposite direction

on the outside of his pockets, they flatten down. This is the way the vein pockets act.

The flow of the blood is aided in some parts of the body by gravity, but in other parts gravity retards the flow. This can be seen and felt by raising one hand above the head for a few minutes, while the other hangs down. Which one has the more blood? How do you know?

The flow of blood is assisted by the muscles contracting and pressing on the veins. This pushes the blood forward; and it can not go backward, because of the vein pockets, or valves. Our exercise of the body brings into action the muscles, and they send the blood on its journey by pressing against the veins, thus hurrying it to the lungs, where it will be purified, and sent around again to repeat its good service.



SHOWING THE COURSE OF THE THORACIC DUCT

The other system of the circulation department, the lymphatic system, we must notice a little further before closing the study of this department.

II. *The Lymphatic System.*— This system does not have the elaborate network of tubes, pipes, and vessels that the blood system contains; neither has it an organ like the heart to send the lymph throughout the body. Yet it is a very interesting and necessary system, and

does a very important work in connection with the blood. The plasma of the blood works its way through the thin capillaries, carrying the food in the blood with it to the cells of the various tissues. You have already learned that what is called *plasma* inside of the arteries and capillaries is called *lymph* after it passes out of the blood vessels. What becomes of all this lymph?

Here is a wonderful provision to prevent a waste of the blood. He who said, "Gather up the fragments that remain, that nothing be lost," planned the circulation of the lymph in such a way that the blood should not suffer loss. It is finally returned to the blood, and becomes plasma on the next journey through the arteries. Some of the plasma returns to the capillaries direct, carrying impurities with it; but by far the greater portion passes through the lymphatic ducts and glands to the heart.

The lymph passes about through the lymph spaces and to the cells, providing them with food, and taking up the wastes that are thrown off by the tissues. After a time, this waste-laden lymph begins to flow into lymph ducts. These ducts have valves on their inside walls that prevent the lymph from going backward. Muscular action presses the walls of the ducts together, and aids in the lymph circulation. Therefore exercise is very necessary to the lymphatic circulation, and a lack of it causes the lymph to become sluggish.

The lymph coming from all parts of the body is finally carried to the heart. From here it is sent to the lungs, and purified ready for a new ministry in the body temple for the comfort and well-being of man.

Life is a great mystery. We do not know what it is. It is manifest in the plant world and the animal world all about us. One thing we do know is that it comes from God. David says, "With Thee is the fountain of life." The life is thought by some to be the blood, because the Bible speaks of "flesh with the life thereof, which is the blood thereof." But the Bible also

speaks of "the breath of life," "the bread of life," and "the water of life." Not all of these can be life itself, but all are necessary to maintain life. We should appreciate this life, and live in harmony with the laws God has given for preserving it.

Questions

1. What two fluids are circulated in the body under the direction of the department of circulation?
2. Describe both of these fluids as to their appearance and composition.
3. What is the work of the red corpuscles? The white corpuscles?
4. How are the tissues of the body nourished?
5. Compare the plan of distributing food and fuel, to a railway system doing the same work.
6. Name the two great divisions of the circulatory system of the body.
7. Give a brief description of the system that circulates the blood.
8. Describe the structure of the arteries, capillaries, and veins, and explain how each is adapted to its work.
9. Describe the structure of the heart, and show how it works as a pump.
10. Trace the blood through the body, beginning with the right auricle.
11. Describe the valves of the heart, arteries, and veins. What is the purpose of each?
12. What causes the heart to beat? Ps. 66: 8, 9; Acts 17: 27, 28.
13. What regulates the heart's beating?
14. What regulates the flow in the arteries and the veins?
15. What is the rate of flow in the arteries? Veins? Capillaries?
16. Describe briefly the lymphatic system.
17. How does it aid the blood system?
18. How are blood and lymph related to each other?

Note Book Requirement

On page 95 write the names of the arteries and veins, and of the ducts of the lymphatic system.

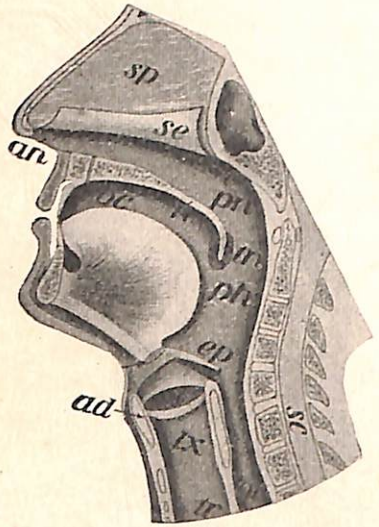
Lesson LXXV

Department of Respiration

(The Respiratory System)

The Spirit of God hath made me, and the breath of the Almighty hath given me life. Job 33: 4.

The respiration department has to do with the proper ventilation of the temple, and also provides the circulation department with some of the fuel for heating the building. The air enters the temple through the nostrils, and passes on through the pharynx, the larynx, the trachea, and the bronchial tubes into the lungs, reaching the minute lung cells, and then returns through the same passages. You already are familiar with the process of exchange of oxygen for carbon dioxide that takes place in the lung cells. It would be well for you to refresh your memory regarding the breathing organs and their operations, by reviewing lesson 98 in Book 2.



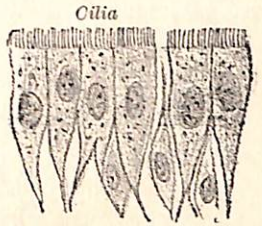
SECTION THROUGH THE FRONT PART OF HEAD

ad, Adam's apple, or cartilage of the larynx; *an*, nostrils; *bc*, mouth; *ep*, epiglottis; *e*, Eustachian tube; *n*, soft palate; *pn*, posterior nares; *ph*, pharynx; *lx*, larynx; *oe*, esophagus; *sc*, spinal cord.

The breathing operation was started when God breathed into man's nostrils the breath of life and he became a living, moving being. Notice that God breathed the breath of life into man's nostrils, and not into his mouth. Many breathe through the mouth, contrary to God's plan; and the result is that the face is deformed and the body suffers much harm. The nostrils are constructed in such a way that the injurious particles are sifted out of the air,

and it passes on into the lungs properly warmed. Job recognized the nostrils as the proper organ for admitting the air. "All the while my breath is in me, and the spirit [breath] of God is in my nostrils."

Let us study more fully the structure of the organs in the respiration department, and notice how well they are adapted to the service they are to render.



CILIATED CELLS IN AIR PASSAGES

1. *The Nostrils.*— In these organs the smelling sentinel is stationed, and he detects the odors and gases that are offensive or injurious to the body, and sends word to the information department not to admit them. The chambers of the nostrils are separated by a thin wall of cartilage. The opposite wall of each chamber is composed of a much folded, wrinkled bone, called *turbinated* bone. The inner surface of these bones is covered with cells of mucous membrane, which prevent the air from drying the nostril chambers. In the deeper folds of the membrane are *ciliated* (hair-like) cells, which keep waving like a field of grain. They move most violently in the direction of the throat. The dust can not pass through the winding passages in the turbinated bones without sticking to them. The waving cilia on the membranes whip the dust particles down into the throat, where they unite with the saliva, and are spit out of the mouth. This device in the nostrils keeps most of the dust from going into the lungs. For this reason, if for no other, we should breathe through the nostrils.

Another reason for breathing through the nostrils, is that the turbinated bones heat the air passing between the folds and the ridges, as a steam radiator heats the air passing over its folds and through its crevices.

2. *The Pharynx.*— This is the first chamber the air passes into after leaving the nostrils. There are seven openings into this curious chamber; two from the nostrils, two from the

ears, one from the mouth, one from the trachea, and one from the gullet. This is not a private room, like some of the rooms of the body. All the food and air that enter the body pass through it. When the food enters the pharynx, it is kept from dropping into the trachea by a lidlike door, the epiglottis, which remains open when we are not swallowing food. The pharynx is a great aid in speaking and singing. It is the resonance chamber that makes the voice rich and musical.

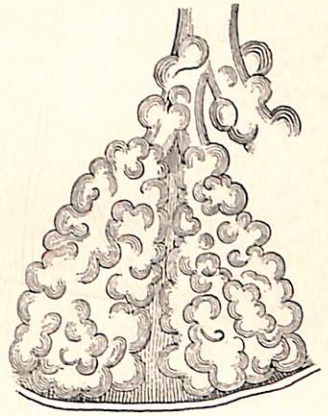
3. *The Larynx.*— Just below the pharynx, underneath the epiglottis, is the larynx. This is the upper portion of the trachea, which is made for the special purpose of producing voice. The voice box is for speaking and singing. The sides of the box are made of several irregular pieces of cartilage. The inside of the larynx walls is covered with a lining of mucous membrane. Two folds of this membrane coming from opposite sides nearly meet in the middle of the passage. The narrow slit between these two folds is called the *glottis*. When the glottis lips are not close together, no voice is produced by the air passing between them. But attached to the cartilages of the larynx are muscles which cause the glottis lips to open and close, and also loosen and tighten them like a cord.

The more forcibly the breath passes between the vocal cords, as they are wrongly called, the louder the voice. The tighter the cords are drawn, the faster they vibrate and the higher the pitch. The quality of the voice depends on the shape of the cavities of the throat, mouth, and nose, and the size of the larynx. No two persons have exactly the same quality of voice.

The voice is a wonderful gift, and we should be careful not to strain the vocal cords by talking and singing too loud and on too high a pitch. Good breathing is necessary to produce a good voice; and singing is one of the best means of cultivating good breathing. The voice instrument — the larynx — is conveniently located, being in the pathway of the air that goes in and out of the lungs while breathing. Let us keep the instrument

in tune, and preserve it in good condition, by avoiding exposures that produce colds and diseases in the throat.

4. *The Trachea.*— The trachea includes the larynx, and extends about four inches further down toward the lungs. The trachea is an open tube consisting of rings of horseshoe-shaped cartilage placed one above another. The open ends of the cartilage rings are united by muscles that contract when one is coughing. The opening of the trachea tube is about three fourths of an inch in diameter. The trachea is lined with mucous membrane containing a large number of ciliated cells, which keep waving their small hairs to throw the dust back and keep it out of the lungs.



LUNG CELLS

5. *The Lungs.*— The trachea divides, just about even with the top of the breastbone, into two branches, called *bronchial tubes*. Each of the bronchial tubes divides again and again, finally ending in wider, funnel-shaped chambers, called *lobules*. In the walls of each of these chambers are many dilated air sacs. Not only the trachea, but also the bronchial tubes and all their branches, are lined with the waving, hairlike cilia, so that the lungs may be kept free from dust. Each of the bronchial tubes forms a lung — one on each side of the chest. The two lungs are divided into lobes. The right lung has three lobes, and the left lung two.

The lungs are provided with means for keeping them clean and pure on the inside, and they are protected on the outside by a double-membrane sac called the *pleura*. When breathing, the lungs contract and expand, causing one sac to rub against the other. This rubbing of the two sacs together would cause friction and irritation did not the membranous sacs furnish an oily fluid that keeps their surfaces well oiled.

Now we have an idea of the air chambers that the air occupies while in the body, but we may not know very much about inhalation and exhalation of the air. This is called *breathing*. What causes the air to go into the nostrils and force its way down into the lungs? And then what forces it out again?

The lungs fill with air just the same as a bellows fills with air. Go to a blacksmith shop, and see how the blacksmith's bellows becomes filled with air. He takes hold of a handle that, when moved, increases the space inside the bellows. As the space is increased, the air rushes in. Now the ribs might be called the handles of the lung bellows. A set of muscles called the *intercostal muscles* raise the ribs, and in that way the space occupied by the lungs is increased. Then the air rushes through the nostrils, into the pharynx, down through the trachea and the bronchial tubes, and into the cells, causing the lungs to fill up the extra space.

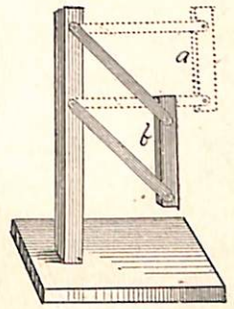
The diaphragm, which separates the lungs from the stomach and other abdominal organs, also helps to increase the space in the chest cavity. You will remember that when at rest, the diaphragm is shaped somewhat like an inverted basin. When it contracts, it flattens, and gives more room for the lungs, which fill with more air, and occupy all the additional space. Do not fail to illustrate what I have said, with a small hand bellows or some other device.

If the ribs projected horizontally from the backbone, then the chest space would not be increased by lifting them, but decreased. But the ribs hang down a little; and the space in the chest is increased when they are raised, until they are level. Let the arm hang at the side of the body. Now lift it slowly out to the side until it is horizontal. The space between the arm and the body constantly increases as the arm is lifted. The same proves true in lifting the ribs.

Job said, "All the while my breath is in me." Can you expel all the air from your lungs? — No, the Creator has not made it possible for us to do that. He so much wants us to live, that He

has not left it with us to control the heart's beating nor the lungs' breathing. We may stop breathing for a few moments, but how hard it is to hold the breath for even one minute! We can not stop the heart's beating at all.

Is the respiratory department under the control of the information department? — Yes; the messages and orders come from the medulla room in the brain office for the respiratory department the same as for the circulatory department. The nerves do not go directly from the medulla to the intercostal muscles or the diaphragm. These nerves first go down the spinal cord, and then pass out between the vertebræ to these muscles. The nerves going to the diaphragm, called the *phrenic nerves*, pass out on both sides of the spinal column, between the vertebræ in the neck, and unite to form a single nerve, which passes down through the thorax, and then spreads out into this large muscle. The nerves that go to the intercostal muscles, called the *intercostal nerves*, go farther down the spinal cord, to the region of the ribs, and then pass between the vertebræ directly to these muscles.

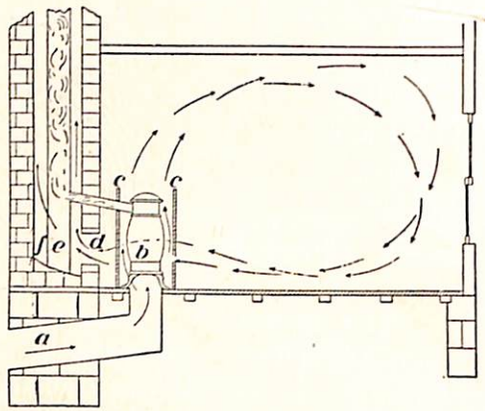


HOW THE CHEST CAVITY IS INCREASED

Very few persons have learned the art of breathing well. Have you mastered this art? If not, you should begin to practice it at once. Use all the lungs you have. God did not give you any more than you need. Many persons breathe almost wholly in the chest. They use the intercostal muscles, but not the diaphragm, one of the largest muscles in the body. It was made large so it could do a large amount of work; and yet some people are so lazy they will not use it at all. Go out of doors, lift your chest, walk briskly, and breathe deeply,— so deeply that you can feel the effects of it in your toes. Many, because they will not use the lungs God has given them, suffer and die of pneumonia, consumption, and other diseases. Some love fashion so much they dress in tight clothing, that crowds the heart,

the lungs, the stomach, and other organs. This mode of dressing also deforms the body.

If the weather were always warm and fair, we could live out of doors more, and could leave our houses open, for the air to circulate through them the year around. But since this can not be done, we must learn how to ventilate our houses. The pure air may be brought into the house and let loose between the stove and the stove jacket. In this way, we secure not only fresh, pure air, but it is warm as well. Ventilation in connection with a fireplace is even better than with a stove; for the air moving up the chimney must be replaced by new, fresh air coming into the room through cracks and crevices if it can not enter any other way. The larger the family, the greater should be the supply of pure air. A schoolroom especially should be well ventilated, because of the many pupils in the room. The inlets for pure air should be near the floor, and the outlets for foul air should be on the opposite side of the room, one near the floor, for the heavy impure air, and one near the ceiling, for the heated impure air. Is your schoolroom well ventilated? If not, see what you can do to improve it. How is it with your sleeping room at home? More air and more covers are much better than less covers and less air. In these days, many sleep out of doors throughout the year. Even schools are conducted out of doors, with only a roof over the children, but with plenty of clothing to protect from the cold.



SECTION OF A SCHOOLROOM HEATED BY A STOVE

Arrows show the course of air currents. *a*, fresh air duct; *b*, stove; *c*, sheet iron jacket; *d*, outlet for impure air; *e*, smoke pipe; *f*, flue for impure air.

Not only foul air is bad, but air filled with dust is apt to contain disease germs, which, breathed into the lungs, will cause sickness. We should see that our rooms are well ventilated, and also kept free from dust. A carpet is a dust collector and a disease breeder. A painted floor, or even a bare floor, is better than one covered with a Brussels carpet. A few rugs, which can be removed and shaken, are far better than a carpet. Lace curtains are dust collectors. A feather duster is a dust scatterer. Do not use one, for you only scatter the dust more about the house. Use moist cloths, and burn them up after using. It would be better if we did not have to sweep at all, but could gather the dust with damp cloths. When sweeping is done, open all the doors and windows, and sweep in the direction the wind is blowing, if it is blowing at all. A windy, blustering day is best for sweeping.

The respiration department of the body demands that the temple be kept warm, clean, and well ventilated. Are you allowing this department to do its work unhindered in your temple?

The invisible, life-giving air that fills the body is the best representation God could give us of the invisible Spirit of God, which He wishes to have dwell in the human temple. As we enjoy breathing the pure air into our lungs, let us also welcome the Holy Spirit into the temple, and enjoy its presence there.

Questions

1. What is the special service rendered by the respiration department?
2. Name the organs of respiration.
3. Describe the structure of the nostrils.
4. Why should the air be admitted through them instead of through the mouth?
5. Locate and describe the pharynx and the larynx, and state the purpose of each.
6. Tell how voice is produced.
7. How may the voice instrument be misused and the voice injured?
8. Describe the trachea and the bronchial tubes; also the lining of the air passages.

9. Give a description of the lungs, the lung cells, and the lung sacs.
10. What diseases occur in the lungs?
11. What causes the air to enter the lungs?
12. Explain the breathing process.
13. Can all air be expelled from the lungs? Job 27:3. Why?
14. What muscles perform the breathing act?
15. What nerves control the breathing muscles?
16. Explain the correct way of breathing.
17. In what way is full breathing hindered?
18. Describe the proper ventilation of living rooms, sleeping rooms, and schoolrooms.
19. What troubles arise from the collection of dust in our homes?
20. Name diseases that come from germs in the dust.
21. What invisible presence and operation in this department represent the invisible presence of the Holy Spirit and its operations in the human temple? John 3:8; 20:19-22; Acts 2:1, 2.

Lesson LXXVI

Sustentation Department

(The Digestive System)

Feed me with food of my allowance: lest I be full, and deny Thee, and say, Who is the Lord? Prov. 30:8, 9, margin.

The sustentation department is the food supply department for all the workers in the body temple. You have already learned something of the work done in this department; but you should now review lessons 101-106 of Book 2 to refresh the mind with the facts there given. There is much more to be learned of the work done in the sustentation department, and I hope that the principles learned will be applied in a very practical way. Paul speaks of some people who are "ever learning, and never able to come to the knowledge of the truth." In other

words, they never apply to the daily life the truths they learn. Let us not be learners only, but doers as well.

What is the purpose of food? Why is it taken into the body? This is a good answer: We eat to live. There are some who do not do that. They seem to live to eat. The wise man knew how the appetite would lead him astray, and he prayed a prayer that we need constantly to pray: "Feed me with food of my allowance: lest I be full, and deny Thee, and say, Who is the Lord?" He recognized that there was danger of overeating, and wanted strength to refrain from eating more than a proper allowance. He knew that to satisfy his perverted appetite would lead him away from his Maker. "Fullness of bread" was one of the sins that brought the wrath of God upon Sodom. The antediluvians were given up to eating and drinking and pleasure, right up to the day of the flood; and Christ said, when on earth, that this same condition would prevail just before His second coming. We find that it is as He foretold; for more time and money are spent to satisfy the appetite than for anything else.

Let us heed Christ's words of rebuke to Satan: "Man shall not live by bread alone, but by every word that proceedeth out of the mouth of God." Spiritual food, the word of God, is more to be desired than our physical food. This is the way Job viewed the matter. He said, "I have esteemed the words of His mouth more than my necessary food." Job 23:12. The prophet Jeremiah enjoyed eating the word of God. He said, "Thy words were found, and I did eat them; and Thy word was unto me the joy and rejoicing of mine heart." Jer. 15:16. The prophet Ezekiel ate the word of God, and bears this testimony concerning his appreciation of it: "Then did I eat it; and it was in my mouth as honey for sweetness." Eze. 3:3. Do you enjoy eating the word of God, as much as you enjoy your physical food? You will if you will eat it as often as you eat your other food, and with a desire to be strengthened by it.

The Lord has given us our daily food to eat and enjoy. He taught us to pray, "Give us this day our daily bread." In Eden He told our first parents what bountiful fare He had provided for them in the fruits, the nuts, and the grains. But man has not been satisfied with what God provided, and eats now many things that are injurious to the body.

I hope that in our study of the work and service carried on in the sustentation department of the temple, we shall learn better these four important things:—

1. Why we eat.
2. What to eat.
3. How to eat.
4. When to eat.

I have already said that we should eat to live. What does it mean to live? Just to be alive? Is that all there is to living? — O, no; to live means to do and to be all that God wants us to do and to be. Let us now consider each of the four important things just mentioned.

1. *Why We Eat.*— We eat to grow. When we are born, we are not as large as God intends us to be. When Jesus was born into this world, He came as a little babe. But the record is, "The child grew, and waxed strong in spirit, filled with wisdom." The physical food He ate caused Him to grow physically. As He "increased in . . . stature," He also grew spiritually and mentally; for He "waxed strong in spirit, filled with wisdom." His spiritual and mental growth was the result of feeding on the word of God, and studying His wonderful works. Jesus' body was a temple in which the Spirit of God dwelt and which it took charge of during His whole life. If we would know what kind of temples we are to be, and how the service in these temples is to be carried forward for the full development of our physical, mental, and spiritual powers, we must study the life and work of Jesus as a child, as a youth, and as a man.

Then one reason for eating food, is that we may grow. And it is the Creator's plan that the spiritual and mental powers shall keep even pace with the physical. While some of the food is used to build up the body, a portion of it is burned up, and so is used as fuel to keep the body warm. The oxygen carried about in the body by the blood and by the lymph unites with the food particles we eat, and the result is heat, just the same as heat is produced in our stoves by the oxygen of the air uniting with coal or wood. In one case, the heat keeps the body comfortable inside; and in the other, it keeps the body comfortable outside.

Why do we grow? What is the purpose of growth? — That we may be strong. We should eat for strength. We must have energy with which to do the work God has for us to do. He says to us all, "Go work to-day in My vineyard." After man sinned, God in mercy said to him, "In the sweat of thy face shalt thou eat bread, till thou return unto the ground." The apostle Paul did not believe a person should eat who would not work; and he wrote, "This we commanded you, that if any would not work, neither should he eat."

The Bible plainly teaches that we are to work, and that only those who are willing to work have any right to eat. In the food is stored up energy that is let loose in the body when the food is eaten, and this is wasted unless used in doing work. Then the reasons why we should eat are these:—

a. That we may grow physically, mentally, and spiritually.

b. That we may have energy with which to work.

c. That our bodies may be provided with heat to keep them warm.

2. *What to Eat.*— As already said, the Creator provided man with a vegetarian diet, consisting largely of fruit, grains, and nuts; and those who hold to this original diet will have the strongest bodies, the clearest minds, and the purest hearts.

Man has so far rejected the bill of fare God gave to him in the beginning, that many animals are now killed and eaten to satisfy perverted appetite. All sorts of beasts and creeping things are listed on the bills of fare in restaurants and hotels. These sheets remind one of the sheet that was spread out before

the apostle Peter, "wherein were all manner of four-footed beasts of the earth, and wild beasts, and creeping things, and fowls of the air." Three times this sheet was presented to him, with an urgent invitation to kill and eat; and three times he refused, saying, "Not so, Lord; for I have never eaten anything that is common or unclean." This is the stand we ought to take when invited to eat things that we should not eat. In times past, God's people have been permitted to eat certain animals that the Lord called clean. One instance was when Noah and his family came out of the ark. All vegetation had been destroyed, and they were allowed to eat flesh food. The Lord fed Israel with manna in the wilderness; but some of them so longed for flesh food, that permission was given them to eat it. But this greatly displeased God, and many of them died while the flesh was still between their teeth.

It may be necessary now, in some countries, to eat meat; but there is no occasion to do so in countries where an abundance of fruits, vegetables, grains, and nuts are raised or can be obtained. On account of rapidly increasing diseases among animals, it is now dangerous to eat flesh food. It will be more dangerous in the future, for we know that diseases will continue to multiply.

The Lord designed that man should get his food first-hand from the fruits of the ground. But it seems that many would rather eat second-hand food. Instead of eating the fruits, the grains, the nuts, and the vegetables, they prefer to have the lower animals eat these first; and when they have chewed them, digested them, and made them over into flesh, then man eats this second-hand food. I would rather eat first-hand food. Wouldn't you?

The Creator put into the soil just those elements which, when taken out of it by the plants, would make good, wholesome food for the animals and for man. The Scriptures speak of this: "He causeth the grass to grow for the cattle, and herb for the service of man: that he may bring forth food out of the earth;

and wine that maketh glad the heart of man, and oil to make his face to shine, and bread which strengtheneth man's heart." "As for the earth, out of it cometh bread."

The chemist, on analyzing the body, finds it to be composed largely of the elements that compose the air, the water, and the soil. Among these are carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, iron, and silicon. In very small quantities, copper, lead, and aluminum also are found in the body. From this we see that, as Paul said, "The first man is of the earth, earthy."

We do not find the elements all separate in the body or in the air, the water, and the soil, but as compounds. The elements of the soil combine in the plant, and form the food materials for man. There are four kinds of food materials, classified as follows:—

a. The Proteid Foods.— This is the material used for building the body temple and keeping it in repair. It can also be used for heating the temple. Proteid is not found usually by itself, but in connection with other food materials. Milk and eggs contain an abundance of proteid. Peas and beans furnish a large amount; and the grains, such as wheat, oats, and corn, supply large quantities, but not so much as the legumes. The vegetables and the fruits contain less proteid; yet on account of their pleasant flavors, they promote digestion, and are therefore desirable food.

b. Starches and Sugars.— Starch and sugar are closely related; and as you already know, starch readily changes into sugar when acted upon by the saliva in the mouth. Both contain much carbon, and for that reason are called *carbohydrates*, which means carbon and water. Starch is especially abundant in grains, seeds, and fleshy roots. Peas and beans yield only a moderate quantity of starch. Sugars are not so plentiful as the starches, and therefore are more expensive. Ripe fruit and honey contain what is called *fruit sugar;* sweet milk, *milk sugar*. *Grape sugar* is found in grapes and honey, and *cane sugar* in cane and beets. Starch and sugar produce heat and energy in the body.

c. Fats and Oils.— Fat and oil also produce heat and energy. Olives, cottonseed, corn, and nuts furnish much vegetable fat, usually in the form of oil. The fats and oils are very important food materials, because they provide so much heat and energy. The Creator has placed them in vegetable food in sufficient quantities that it is wholly unnecessary to take the life of animals to secure fat.

d. Minerals.— The mineral food materials are water and salt. They do not produce heat or energy. Water enables the blood to flow, and thus it helps to distribute the food to the tissues. About two thirds of the body by weight is water. Many do not drink enough, consequently the blood does not flow freely, and the workers in the sustentation department find difficulty in distributing the food to the various tissues. While there is danger of eating too much food, there is no danger of drinking too much water, provided we do not drink during mealtime, or during the hour just before or the one just after meals.

Proper Combinations of Food.— The great problem cooks have to work out is the combining of the food materials in just the right proportion to build and heat the temple properly, and furnish a sufficient amount of energy to all the workers in the temple, so that the service will be promptly and faithfully carried on. The amount of food material necessary to supply the body each day is about one and one fourth pounds, not counting the water. One fourth of a pound should be proteid, for building and repairing; and of the remaining pound, there should be about equal portions of starch and fat, for heating and producing energy. The starches and the sugars are so abundant in most foods that there is not likely to be a lack of them at any meal. But this is not true of the proteids and the fats, as they are much less abundant. Hence cooks should be careful to provide such foods as will furnish one fourth of a pound of proteids each day. If much more than this were eaten, it would be detrimental to the body. Not less than one eighth of a pound

of fat should be eaten daily. If there should be a lack of starch, its place could be provided by eating a little more fat or sugar; but nothing can take the place of proteid.

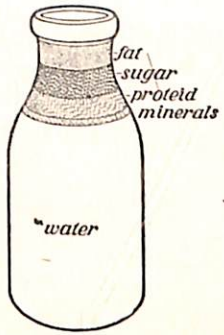


DIAGRAM OF BOTTLE OF MILK

Description of Common Foods.— Milk is the most nearly perfect food we have, the materials being combined in it in the right proportions. It was made for infants and small children, and other foods must be added to it for adults.

Butter is mostly the fat of milk. It contains nothing for building up the body, but is used with other foods, like bread and potatoes, which are lacking in fat.

Eggs are an animal food, as are milk and butter; but the use of them does not require the taking of life, as in the case of meats. If the chickens and the cows are well kept, and do not become diseased, milk, butter, and eggs are safe foods to use. Eggs furnish a large amount of proteid and fat, and should be eaten with foods containing starch, which is wanting in eggs.

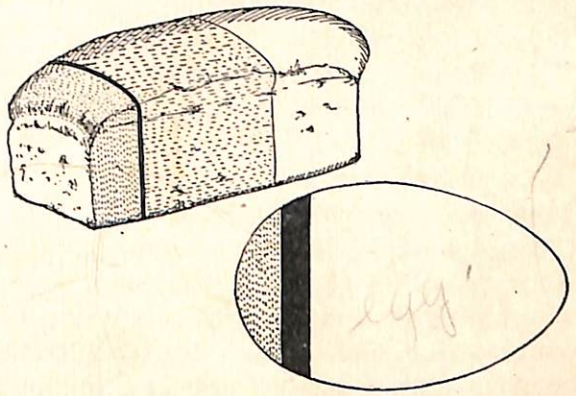


DIAGRAM OF A LOAF OF BREAD AND AN EGG

Fats are shown in black, starch in horizontal dotted lines, and proteids in vertical dotted lines. Other parts are water.

Bread is one of the best foods. It is truly the "staff of life." It contains some proteid, and a large amount of starch. There is not sufficient fat in bread to make it a perfect food, therefore bread is commonly eaten with cream or butter. Cream is better than butter, for it is more easily digested.

Cereals, or grains, are excellent foods, and are of equal value with bread. They are rich in proteid and starch, but are somewhat lacking in fat. With cream, cereals are almost perfect foods.

Rice has less proteid than has wheat, and very little fat. It should be combined with some food supplying more proteid, as peas and beans.

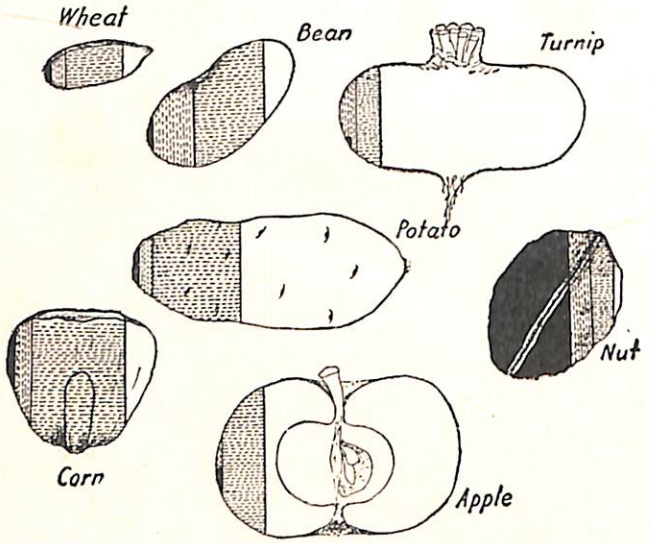


DIAGRAM SHOWING NUTRITIVE VALUE OF DIFFERENT FOODS

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Beans and peas furnish very large amounts of proteid, even more than meats, and therefore remove all excuse for taking life to secure good food. They also contain considerable starch, but their chief value is in the proteid they provide. They should be eaten with food containing starch and fat. Peas and beans are somewhat difficult to digest with the skins on, but are easily digested if the skins are removed by pressing through a colander.

Potatoes contain very little proteid, some starch, and little fat. They are of slight value if used alone, and must be eaten with foods that will supply the proteid lacking. Potatoes furnish a considerable amount of starch, and are good to eat with eggs, peas, and beans.

Vegetables usually contain very little food material, and by themselves are not of much value; but they possess flavors that

are pleasant, and thus encourage the action of the digestive organs. Vegetables consist largely of coarse, indigestible fiber, which tends to prevent clogging of the digestive canal.

Fruits supply about the same food materials as vegetables. Their flavors excite the digestive organs, and thus help to regulate digestion, even though they may not furnish much nutriment. Fruits also furnish acids that kill germs and keep the digestive canal pure. By eating fruit alone for one or two days, the whole digestive system will be cleaned, and much more good done than by medicines, with less cost. Baked sweet apples are the most digestible of all fruits, and ripe apples digest very quickly.

Nuts contain fat, and some of them much sugar and proteid. Nut fats are a good substitute for animal fats, and we should be learning how to use them, so that we shall have them for use when, on account of animal disease, it will be unsafe to eat butter. Some people have tried nut butter as a substitute for dairy butter, and claim it is not satisfactory. They say it is difficult to digest. The fault is not with the nut butter, but with the user. It is so rich and concentrated that it must be eaten in very small quantities. If it is used as freely as dairy butter, it is very difficult to digest. When properly prepared and properly eaten, nuts will be found just what the Lord designed them to be — a wholesome, nutritious food.

Sweets are thought to be a necessary food. The sugars are the sweets that God has provided, and placed them along with other food materials, in the proportion needed. Some very sour foods need sugar in them, just as some insipid foods need salt; but many good foods are spoiled by putting sugar or salt into them. Worst of all are the candies and sweetmeats that are sold at the confectionary, grocery, and drug stores. These sweets are destroying the digestive organs of thousands upon thousands of children, youth, and grown people. And when the organs that God made to digest and assimilate our food are weakened or destroyed, how is the temple to be built up and

heated? And how are the workers in it to receive energy to do their work?

Each year there is used, in the United States, an amount of cane sugar equal to seventy-five pounds for every man, woman, and child. And what is worse, an average of thirty pounds of candy for each person is used. What great mischief is done by these sweets! This is what one of Chicago's greatest doctors says about it: "Medical treatment is powerless to prevent the disease and degeneration that is now going on as a result of the abuse of sugars and sweets. Our only hope lies in the education of the masses along hygienic lines. The evil begins its work in early childhood. The gout and diabetes of old age are prepared for in youth. The gall stones of middle age begin to form early in life."

I am sure you want strong, healthy bodies, and are willing to do without all those things that would mar or destroy these temples God has given. Think of the amount of money spent to buy thirty pounds of candy for each man, woman, and child in this nation. How many pounds of candy would that be? How many carloads would it make, if each car would hold thirty thousand pounds? How many trains would be required to ship that candy about the country, if each engine would pull fifty cars? How much is paid for this candy, if it costs ten cents a pound? If that money were not spent for candy, people would have better health, and be happier, and the money could be used to help send the gospel to those who do not know that their bodies belong to God.

3. *How to Eat.*— The purpose of eating should have much to do with the manner of eating. Strength of body and mind and spirit, for the best and largest service possible, should be the primary object in eating and drinking. This is eating and drinking to the glory of God.

We should eat in such a way as to get the most out of our food. It is to furnish us with building material, heat, and energy. But before it can do this, it must be prepared by the digestive

organs so that it can be taken into the blood. Then let us see that plenty of time is given for the teeth to grind the food, and for the digestive juices to digest it. If this is done, we shall not eat a meal in five or ten minutes, but instead, we will engage in pleasant, profitable conversation at the table, enjoy eating our food, and a half hour at least will pass before we have finished the meal.

Another very important matter is, not to overeat. It is better to go away from the table a little hungry, than to eat too much. If we overeat, we overburden the digestive organs, and they are not able to do their work well. Only the food that is digested does any good, and the rest does us harm. Many eat until their hunger is satisfied, and then they continue to eat, because "it tastes good." The dessert is usually taken after one should stop eating. Rather than eat too much, it would be far better to go without the dessert entirely, or to eat it first.

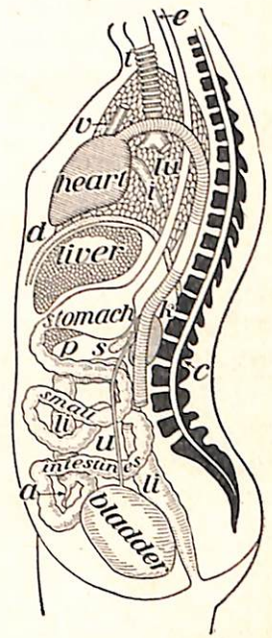


DIAGRAM SHOWING RELATION OF THE ORGANS OF THE BODY CAVITY

a, vermiform appendix; *c*, spinal column, inclosing the spinal cord; *d*, diaphragm; *e*, esophagus; *i*, the great vein, or vena cava; *k*, kidney; *lu*, lung; *li*, large intestine; *p*, pancreas; *s*, spleen; *t*, trachea; *u*, ureter; *v*, vena cava.

4. *When to Eat.*— The best rule to follow is this: Eat when you need food. We should have regular times for eating, not too far apart, and not so close together that the digestive organs will have no time for rest. There should be no eating between meals. It is better to eat three meals a day, and not overeat, than to eat two meals, and get so hungry that we overload the stomach. Not less than five hours should elapse between meals. If the food is easily digestible, this will give time for the stomach and the intestines to do their work, and have a period of rest before the next meal. An exact program as to the time of eating will not fit every case. Good common sense and

experience should be allowed to have a part in deciding when to eat.

Here is a brief outline of the work of digestion:—

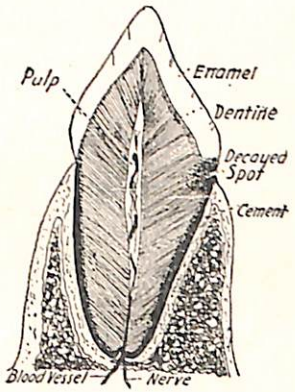
The digestive canal, which is called also the *alimentary canal,* is about thirty feet long. The food is changed in this canal into a liquid solution; and that which is to be used by the body is absorbed by the blood vessels and the lymph ducts in the walls of the canal.

The work done in the sustentation department by the digestive system is most interesting to study. How dead, lifeless soil, water, and air can become a living plant is a great mystery. And how plant food can be changed into human flesh,— part of it becoming bone, part of it muscle, another part nerves, and still another part skin,— is also a great mystery. We can, however, learn something of the processes of digestion that the food passes through on its way to become a part of the body.

The Mouth.— In the mouth are instruments for cutting the food up into small pieces and grinding it — the *teeth.* The body of the teeth is composed of a bonelike material called *dentine.* The visible surface of the teeth is covered with a hard, shining *enamel.* The enamel stops just below the gums, where it is overlapped by the cement of the roots. Each tooth contains a soft, fleshy substance known as *pulp.* This is composed of connective tissue filled with nerves and blood vessels, which enter at the tip of the root. Some of you know that a tooth has nerves, because you have had toothache. You should preserve your teeth from decaying, as they are very necessary tools. Many children cause their teeth to decay by eating candy and sweetmeats. Poor digestion also causes the teeth to decay. Your teeth should be thoroughly cleansed after eating. They were made to use; and you should eat hard food, that will give them work to do. The harder they work, the better they thrive. If one of your teeth aches, have a dentist attend to it at once.

How many cutting and grinding teeth are there in your mouth? This depends on your age. When about six months old,

the baby's first *temporary* teeth appear; and by the time it is eight years old, the child will have twenty teeth. As the teeth do not grow as fast as the jaw, another set, the *permanent* teeth, start to grow deeper down in the jaw, and in time will crowd the others out unless they are pulled. Some of you were afraid to have your baby teeth pulled, and the new teeth crowded them out; and so now, instead of having straight teeth, you have crooked ones. But take good care of those you have, and do not by carelessness or laziness lose one of them. Some children are too lazy to brush their teeth; and for that reason, they have bad-smelling breath and an ugly-looking face.



SECTION THROUGH A TOOTH (MAGNIFIED)

When one is about twelve years of age, all the permanent teeth have appeared, except the four wisdom teeth. They appear between the years of twenty and twenty-five. The second set has thirty-two teeth. Beginning at the front of the mouth, the teeth on each side of the upper and the lower jaw are arranged in the following order: two *incisors* and one *canine,* all of which are for cutting only; two *bicuspids,* called also *premolars,* used for both cutting and grinding; and three *molars,* designed wholly for grinding.

While the food is chewed, or masticated, in the mouth, it is moistened by a fluid called *saliva.* This is furnished by three pairs of salivary glands, one pair located in the cheeks, just in front of the ears; one pair beneath the lower jaw; and the third pair beneath the tongue. The saliva produces a chemical change, converting the starch into sugar. It flows into the mouth through ducts from the salivary glands. It is caused to flow by chewing, or even by the smell and sight of food. Many persons do not chew their food well, and this makes the work of digestion in the stomach more difficult.

Some people think the chewing of gum helps the work of digestion. This is not true; for gum chewing wastes the saliva, weakens the glands by overworking them, and the stomach is irritated by the continual swallowing of the saliva. The chewing of gum is a coarse, impolite habit, and causes not only a waste of saliva, but also a waste of money.

In the act of swallowing the food after mastication, it passes into the pharynx, over the epiglottis, down the tube called the *gullet,* into the stomach. This gullet, also called the *esophagus,* is a tube about nine inches long. It is lined with mucous membrane, and consists of two layers of muscle, the fibers of one layer being circular, and those of the other layer running lengthwise. When the food enters the pharynx, the muscular walls of the pharynx contract, and push the food into the gullet. The ring muscles of the gullet one after another contract, and push the food down into the stomach.

The pleasure of eating is in the tasting of the food. Then why should we hurry the food on and swallow it before we get all the taste out of it? Mr. Gladstone, one of England's greatest statesmen, believed in chewing his food thoroughly. He said that each mouthful should be chewed thirty-two times, so that every tooth would get a chance at it. People who eat in this way are more likely to have strong bodies and strong minds, and to live to a ripe old age, as Mr. Gladstone did.

The Stomach.— This is a large muscular bag lying sidewise in the abdominal region. Its walls are made up of three layers of muscles, the fibers of each layer running in a different direction. In one layer the fibers run crosswise; in another, lengthwise; and in the third, slantwise. When the food enters the stomach, these muscles contract, one layer at a time. The result is a churning motion. The food is thoroughly mixed with the gastric juice, which is secreted by the gastric glands in the mucous lining of the stomach.

This churning process goes on from two to four hours after the meal is finished. The length of time depends upon how well

the food has been chewed, and the kind of food eaten. In the mouth and the stomach the food is changed into a creamy, semi-fluid mass called *chyme.* Then it passes out through the *pylorus,* or gate keeper, into the intestine. This gate keeper is a fold in the tube connecting the stomach with the small intestine. It forms a sort of valve that will not allow the food to pass out until it is made into chyme. The chyme does not pass out all at once, but the pylorus opens and shuts every minute or two, letting a little out at a time. After several hours, it opens wide the gate, and lets all the chyme that remains, and any undigested food, pass through into the small intestine.

The Small Intestine.— This is a tube about one inch in diameter and twenty feet long, and is an important digestive organ. Some of the starch is digested in the mouth; some of the proteid, in the stomach; but here in the small intestine the remaining portion of the starch and proteid is digested, also the fats and the cane sugar. You see that the small intestine has to do what the mouth and the stomach have failed to do. The food remains in the mouth a few minutes, in the stomach two or three hours, and in the small intestine from ten to twelve hours.

There are thousands of little glands, called *intestinal glands,* that secrete the intestinal juice. This juice digests the cane sugar that was not acted upon by the saliva nor the gastric juice. Two other digestive fluids are poured into the intestines from organs near. One is the bile, which digests the fats; and the other is the pancreatic juice, which acts on the starch and the proteid, and helps the bile to break up the fats.

The mucous lining of the small intestine is full of wrinkles and folds, which are covered with millions of little threadlike projections that absorb the digested food and pass it into the blood.

The Liver.— This is a chocolate-colored organ weighing about three pounds, located just beneath the diaphragm, on the right side of the body. It performs a very important threefold service:—

1. It is a storage room for the body. Digested sugar and starch are stored away in the liver, and then are given out as the body needs them.

2. The liver examines all the blood as it is passing through on its way to every part of the body. Any poisonous substances that are found are, as far as possible, sent out of the body. Alcohol, coffee, morphine, and other injurious substances are thus held up by this faithful guardian of the temple. Twice as much poison is required to destroy life, if taken through the mouth, as when it is injected into the blood through the skin. Why?

3. The liver secretes bile. The bile is largely made up of waste materials; and yet it aids the pancreatic juice in digesting the fats. It is the plan of the Temple Builder to turn everything in the body to some good use. Let us, in building character, turn even the undesirable circumstances and conditions around us to good account.

The Large Intestine, or Colon.— This is about five feet long and two and one half inches in diameter. The small intestine unites with it in the lower right side of the abdominal cavity. There is a valvelike fold where the two join together. Just below the place where the small and the large intestine join is a short, hollow tube called the *vermiform* (worm-form) *appendix*. This sometimes becomes inflamed, and causes the disease known as *appendicitis*. In the colon, the watery portion of the food continues to be absorbed by the villi; but there is no fluid secreted that carries on any further digestion.

This is the way the food is prepared to be taken into the blood, and distributed to all parts of the body, ready to be made into the different tissues. It feeds the cells, and the cells grow and multiply. It is in the cells that the digested food particles are changed into living flesh and bone. How, we do not know. We are curiously wrought in secret, and these bodies are to us a continual wonder.

Surely the sustentation department has a very important work to do. The sympathetic nerves from the information department

look after the digestive organs in a general way, so that the main office, the brain, does not carry this responsibility. Of course, if the food supply runs short, the stomach then sends word directly to the headquarters of the information department, and the locomotion department is wired to provide more food. If there are disorders in the stomach, then notice is sent to the brain, and steps are taken to relieve the stomach.

Questions

1. Why do we eat food? What prayer should we offer about our eating? Why? Prov. 30: 8.
2. What was one of the great sins of the Sodomites? Eze. 16: 49. Is this same sin committed to-day?
3. What did Christ say as to the condition of the people before the flood, and those who would live just before His second coming? Matt. 24: 37-39.
4. What food is man to eat that is more important than his daily bread? Matt. 4: 4; Job 23: 12.
5. Give three reasons for eating food.
6. Describe the growth and development of the child Jesus. Luke 2: 40, 52.
7. What command did Paul give with reference to eating and work? 2 Thess. 3: 10.
8. What are the three leading classes of food that the Lord provided for man?
9. How has man departed from the original diet?
10. What should be our attitude toward a flesh diet? What was the apostle Peter's attitude? Acts 10: 9-16.
11. From what place does our proper food come? Ps. 104: 14, 15; Job 28: 5.
12. Name the elements in the body and in the soil. How do they compare?
13. Name the four classes of food materials, and the purpose served by each in the body. Give examples of foods containing these food materials.
14. What is the value of fruits as a diet? Of vegetables? Of nuts?
15. What false witness is borne against nuts as a food?
16. What true testimony is borne against the use of sweets?

17. Give a few principles that should guide us in our manner of eating.
18. Give briefly the process of digestion.

Note Book Requirements

1. On page 101 locate and describe the papillæ of the tongue.
2. On page 102 write the names of all the digestive organs, and briefly tell the work performed by each one.
3. Name on page 103 the four food materials, and give examples of the most perfect foods; also write out three lists of foods that will combine well, one list for breakfast, one for dinner, and one for supper.

Thurs.

Lesson LXXVII

The Elimination Department

(The Excretory System)

And he shall put off his garments, and put on other garments, and carry forth the ashes without the camp unto a clean place. Lev. 6: 11.

In the service of the tabernacle and the temple, all that was left after the fire consumed the offering, and all that was not to be burned upon the altar, the priests were required to take away and burn outside the camp. The priests changed their clothing before carrying away this refuse. "And he that burneth them shall wash his clothes, and bathe his flesh in water, and afterward he shall come into the camp." From these scriptures, we see how particular God was that everything about the tabernacle and the temple should be kept clean and sanitary.

The Lord has made provision for keeping the human temple clean, and the surroundings sanitary; and He is just as particular about it, as He was with the temple built by Solomon. The commandment then was, "Be ye clean, that bear the vessels of the Lord." The priests who handled the vessels of the sanctuary were to be clean because the vessels were holy. How much more should we who are called "vessels of honor" be clean in body and mind! "If a man . . . purge himself from these, he shall be a vessel unto honor, sanctified, and meet for the Master's use, and prepared unto every good work." This is a wonderful promise, which the Spirit of God will fulfill to each one whose body is a temple of God.

Let us now consider what provision has been made for removing all wastes from the body temple, so that it may be kept clean and strong. We have learned that not all the materials taken into the body are used in heating, building, and repairing it. Then, again, the ashes left from the fires heating this temple must be removed; and the worn-out material must be carried away whenever any repair work is done. This work of removing all wastes is under the supervision of the elimination department, which does the work through the excretory system. There are four sets of organs, or parts of the body, that have the janitor work to do in the temple, and they are very faithful in doing their work. Let us now consider the work done by each.

Thurs.

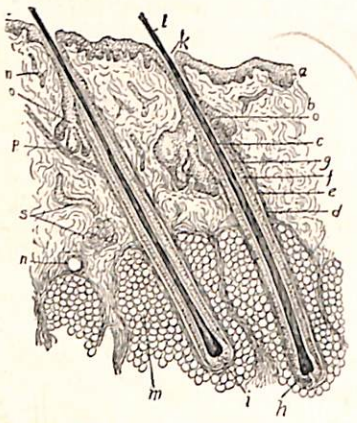
1. *The Lungs.*— We have already learned something about the valuable service performed by the lungs in providing oxygen. This oxygen, which keeps the fires burning, is distributed by the blood; and this same blood gathers up the carbon dioxide, which we may liken to ashes, and carries it back to the lungs. It is forced out of the lungs through the nostrils and the mouth. The carbon dioxide must not only be taken out of the body, but it must be carried outside the "camp"— the home; and this is why a good ventilation system is so necessary.

2. *The Intestines.*— A portion of the food that we eat can not be changed by any of the digestive fluids in the mouth, the stomach, or the intestines. Therefore much waste is collected in the large intestine, and passes from the body.

3. *The Kidneys* are two bean-shaped organs, one located on each side of the backbone, just below the eleventh pair of ribs. These organs take from the blood certain impurities, and these

are conveyed to the bladder, from which they pass in a liquid state.

4. *The skin* is a wonderful garment, elastic and neat-fitting. If a section of it is placed under a microscope, it will be found to consist of two distinct layers. The inner layer is called the *dermis* — a word meaning *skin.* This dermis is full of minute nerves, blood vessels, and glands. The outer layer is called *epidermis,* meaning "upon the skin." It is tough and strong, but is lifeless, having no nerves nor blood vessels, except a very thin layer next to the dermis. You have cut the skin, and it did not pain you nor bleed, because you cut only the epidermis.



MAGNIFIED SECTION OF SKIN

The epidermis develops hair and nails. The hair roots penetrate into the dermis, and close to them are oil glands, which secrete and pour oil into the little root pockets called *hair follicles.* This oil keeps the hair from becoming dry and stiff.

Other glands called *sweat glands* are very numerous in the dermis. Each sweat gland has a coiled tube which opens on the surface of the skin. Through these openings, or pores, the watery fluid formed in the coils escapes. We call it *sweat,* or *perspiration.* Usually it evaporates as fast as it comes to the surface; but on sultry days, when the air is full of moisture, the perspiration forms into drops on the surface of the body. It is largely water, but contains impurities that have been brought to the sweat glands by the blood. Think how much waste and impure matter is carried from the body, through the pores of the skin. Do you know how many pores there are? There are about two and one half million sweat glands working night and day to keep the temple clean on the inside, besides the three other janitors just studied.

The refuse material must not only be carried out of the temple, but it must be carried without the camp. This is done by washing the outside of the temple; and the water containing the impurities is conducted away to places provided for wastes.

The temple, then, is to be cleansed inside and outside. Water is the great cleansing agent. The drinking of water is one part of the cleansing process. Bathing is another. If this is neglected, the pores become clogged, and the work of eliminating the impurities is hindered. From one to five pints of perspiration is secreted by the sweat glands each day. The amount depends on the exercise taken and the condition of the air. Vigorous exercise causes rapid perspiration, and the body is soon covered with impurities. The particles of waste are so small that you can not detect them with the naked eye; but if allowed to remain on the body, their presence will soon be detected by the sentinel that stands on guard in the nostrils. Other persons will be able to detect the unsanitary condition of your temple much better than you can.

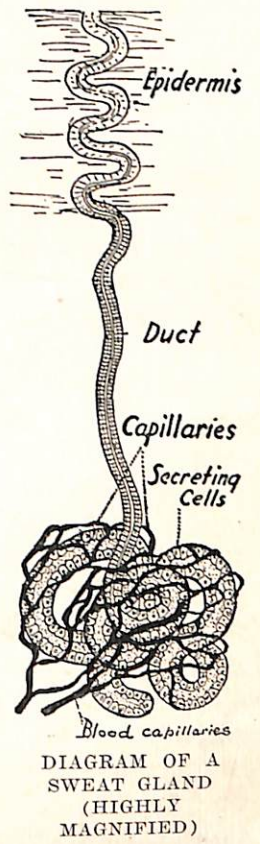


DIAGRAM OF A SWEAT GLAND (HIGHLY MAGNIFIED)

The taking of a bath should become a habit. A person need not take one every day, and yet if it is properly taken, no harm will come from this practice. Do not bathe within three hours after eating. Give the stomach a chance to do its work, before you call the blood elsewhere.

Cleanliness is not the only benefit derived from bathing. The effect on the skin is stimulating and helpful. The cool bath produces a shock to the nerves of the skin, and causes the blood vessels to contract, and for a few moments the skin becomes white and cold; but a reaction quickly follows, the blood vessels enlarging and bringing more blood into the skin. This causes

a warm, glowing feeling in the body which is very pleasant to experience.

The skin is a protection to the body against disease germs. The many overlapping epidermis cells form such a thick mass that the germs can not penetrate it and reach the living tissues beneath. But if the skin is cut or bruised so that the dermis is exposed to the air, the germs attack it at once. For this reason, some strong germ-killing medicine must be applied to destroy the bacteria.

Burns and frostbites are very common accidents that destroy the skin, and it is well to know what to do for healing these injuries. Ordinary burns can easily be treated by plunging the burned part into cold water; or by bathing it in water containing common baking soda, and then applying sweet oil or vaseline.

If the clothing catches fire, wrap anything like a rug, a blanket, an overcoat, or a shawl about the body, to extinguish the flame. After the fire is out, remove the clothing so carefully as not to break the skin. Then anoint the skin with sweet oil or vaseline. If the burn is severe, a doctor should be called at once. If the skin is destroyed, so that it can not grow again, skin from another person's body can be placed firmly on the raw surface, and will grow and spread over the wound that would not heal. This process is called *skin grafting*.

A case of frostbite may be treated by rubbing the frozen parts with snow or cold water, so that they will thaw out slowly. When this is done, the body should be warmly wrapped, and the patient after a time should drink some hot beverage.

We must dress in such a way that our bodies will be protected and kept strong and well. We should dress to fit the temperature of the place where we spend most of our time. If one's work is indoors, he should dress to keep warm where he is doing his work, and then put on more clothing when going out of doors. If one is out of doors working in the cold winter weather, he should dress so that he will keep comfortable while working, and not when he is idle.

Questions

1. What cleansing work was carried on continually in the tabernacle?
2. What preparations were made by the priest before doing this cleansing work? What was done afterward? Lev. 16:28.
3. Why was this cleansing work necessary? Isa. 52:11.
4. What besides a temple does Paul call this body? 2 Tim. 2:21. What is necessary to become a vessel of honor?
5. What provision has been made for keeping the body temple clean? Name the four janitors that keep the temple clean.
6. What do we have to do to coöperate with their efforts?
7. Explain the work done by the lungs, the kidneys, and the intestine.
8. Describe the structure of the skin. What work does it do in eliminating wastes from the body? Give a description of the sweat glands and their work.
9. How can we coöperate with the skin in removing wastes from the body?
10. What are the benefits to be derived from taking a bath? When should baths be taken?
11. In what way does skin protect the body?
12. How should burned and frozen skin be treated?
13. What should determine the kind and amount of clothing we wear?

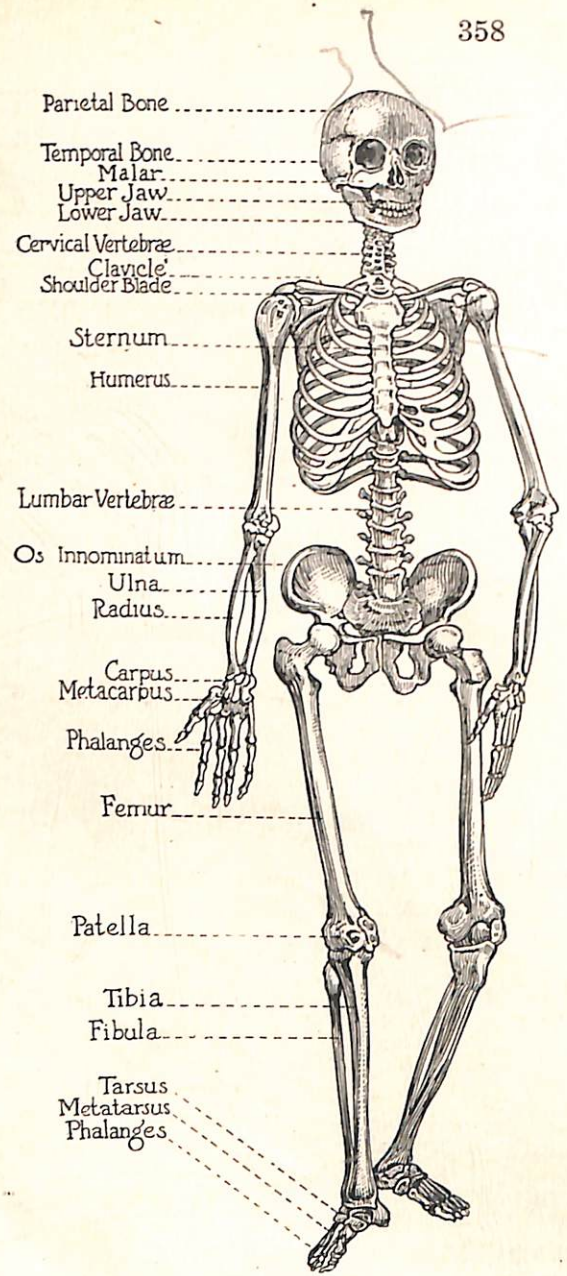
Lesson LXXVIII

The Stabilization Department

(The Osseous System)

He knoweth our frame; He remembereth that we are dust. Ps. 103:14.

The stabilization department has the responsibility of looking after the form and stability of the temple. This is done



SKELETON

through the osseous, or bony system, which forms the frame of the temple. Without this framework, whose beams and braces are bones, there would be no stability to our temple structure. The bones are more like the soil and the dust than are any of the other tissues of the body. When David considered the weakness and frailty of man's body, he took c o u r a g e in the thought that God knows our frame, and remembers that it is made of the dust. He prayed this prayer, which we also should pray: "Lord, make me to know mine end, and the measure of my days, what it is; that I may know how frail I am."

The bones give the body a rigid, strong form; but w i t h o u t the ligaments to bind the bones together at their joints, the framework would be very unstable. There are more than two hundred bones in the h u m a n

frame. They are of various sizes and shapes, each bone being made for a special purpose. The use of the bones reveals God's wisdom; but the names reveal only man's wisdom. We shall divide the skeleton into three parts, and study the bones of each part separately.

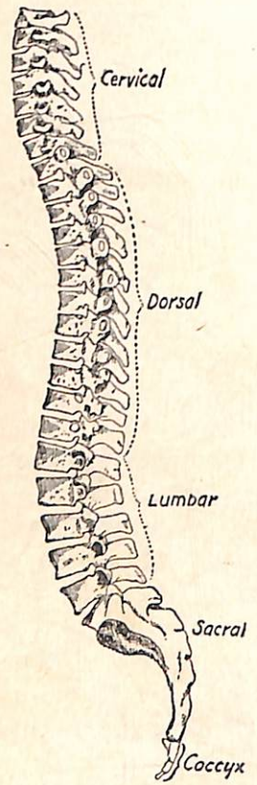
1. *The Head.*— No organ is more strongly and safely protected than the one with which we do our thinking, seeing, hearing, smelling, tasting, and feeling — the brain. The casket containing this precious treasure is made of solid bones dovetailed closely together so that it can not come apart. It is composed of eight bones, which united are called the *cranium,* or *skull.* These are the names of the cranial bones: one *frontal,* in front; one *occipital,* at the back; two *parietal,* on the top and sides; two *temporal,* on the sides and bottom; one *sphenoid,* beside and back of the eyes; one *ethmoid,* back of the nostrils. The names and location of some of these bones are shown in the illustration.

Besides the eight cranial bones, there are six other principal bones that help to form the face. The two *malar* bones form the cheeks, the two *nasal* bones the nose, and the two *maxillary* bones the jaws. There are fourteen bones in the cranium and the face, and three bones in each ear, making all together twenty bones in the head. Most of the nose and all the external ear are made of *cartilage,* which is not so hard as bone.

2. *The Trunk.*— The spinal cord, which passes out of the cranium downward along the back, is well protected by a series of bones placed one on the top of another, twenty-six high. Between the vertebræ are elastic cushions of cartilage, which keep the vertebræ from rubbing one another, and also lessen the jar to the brain when walking, running, and jumping. Near the back of each vertebra is a round opening, through which the spinal cord passes. The first seven vertebræ are called the *cervical* vertebræ; the next twelve below are called *dorsal* vertebræ; and the next five, the *lumbar* vertebræ. Below these are five vertebræ grown together to make a support for the spinal column

above, and also a strong connection for the hip bone, which supports the trunk. These five vertebræ are called the *sacrum;* and below them are three more, partially grown together, called the *coccyx.*

The spinal column, or backbone, as it is commonly called, is wonderfully made. It has four curves, which give a more graceful form to the body than it would have if it had been made straight. They also afford more spring and elasticity to the body than would a straight backbone. The spinal column being composed of twenty-six separate bones, the body can bend without difficulty.

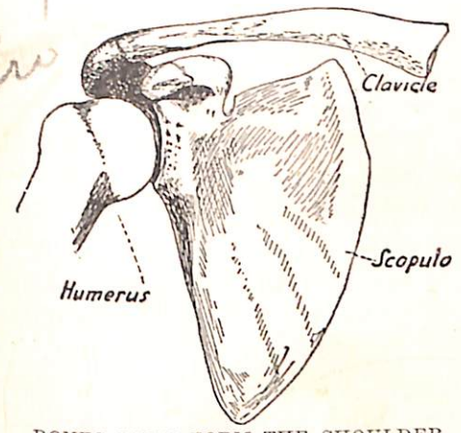


SPINAL COLUMN, SHOWING CURVES AND THE SEPARATE VERTEBRÆ

The backbone enables man to walk uprightly. And yet there are some people — yes, some boys and girls — who go around with bent backbone and stooped shoulders, as if they would rather walk like the monkeys and the baboons. Let us decide right now that we will use our backbones, and all our other bones and muscles, just the way the One who framed our bodies intended we should.

Attached to the dorsal vertebræ are twenty-four ribs, twelve on each side of the backbone. The seven upper pairs are joined in front to the breastbone. The two lower pairs are termed *floating ribs.* The breastbone, called the *sternum,* extends down the middle of the chest. The ends of the ribs are composed of cartilage, which makes them more flexible. The backbone and the sternum, with the ribs, make the chest cavity, called the *thorax,* which contains the lungs. In the trunk we have a total of fifty-one bones,— twenty-six vertebræ, twenty-four ribs, and the sternum.

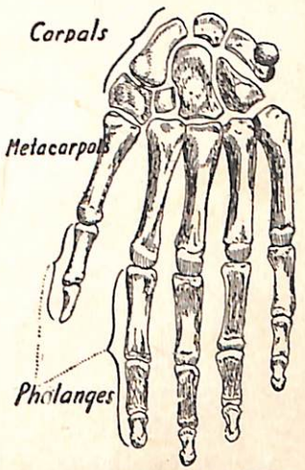
The Limbs.— The upper limbs consist of the shoulders, the arms, and the hands. The shoulder blade is formed by the large, flat, triangular bone called the *scapula,* and is located on the back of the shoulder joint. Into this the *humerus,* the upper bone of the arm, is fitted, the two forming a *ball-and-socket* joint. This is the kind of joint that gives the freest movement to the bones. From the sternum to the scapula runs a brace bone, called the *collar bone,* or *clavicle.*



BONES THAT FORM THE SHOULDER JOINT

Below the humerus are the two bones of the forearm, called the *ulna* and the *radius.* The ulna is attached to the humerus by a hinge joint, which allows the bone to move in two directions only — forward and backward. The radius, which is on the same side as the thumb, joints with some of the wrist bones.

In the wrist are the eight very small *carpal* bones. Following these are the five *metacarpal* bones, which form the frame for the palm of the hand. These metacarpals are jointed with the carpals, and with the *phalanges* — the bones of the fingers and thumb. Each finger contains three bones, and the thumb two.

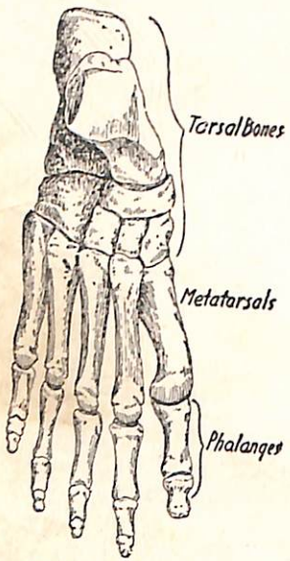


BONES OF THE HAND

There are thirty-two bones in each upper limb.

The lower limbs are used in moving the temple from place to place. The *femur,* the upper bone of the leg, is fitted into the

large hip bone by a ball-and-socket joint. The femur extends down the leg to the knee. The hip bone is very large and queer-shaped, and contains the socket for the leg. Scientists not knowing what to call this queer-shaped bone, it was finally named *os innominatum*, which means the "unnamed bone." The ball-and-socket joints give great freedom of movement to the legs. The *patella* is the small bone of the knee, sometimes called the *knee-cap*.

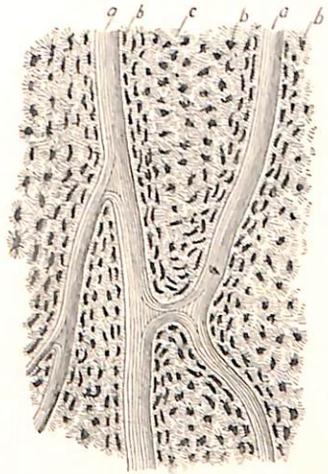


BONES OF THE FOOT

Between the knee and the ankle are the two bones called the *tibia* and the *fibula*. The tibia connects with the femur at the knee. The fibula does not connect with it, but makes a slight connection with the ankle bones, called the *tarsals*. The seven tarsal bones are followed by the five *metatarsals*, and these by fourteen phalanges. The phalanges of the feet correspond to those of the hand. The number of bones in the lower limbs is sixty-two.

Now we have examined the entire framework of the body temple, and find that it gives form and strength to the temple, and affords a protection to the workers within. Perhaps you would like to examine the bone timbers a little more closely, and see how they are constructed. They are hard, almost like stone, and yet they are alive. They are composed of cells, like the other living matter of the body. Here are two views of bone as seen under a microscope. One is an end view of a bone sawed crosswise, and the other is a side view of a bone sawed lengthwise. The black spots that look like black ants with their legs sticking out, are the bone cells. The bone canals are distributed all through the bone, and contain blood vessels, which supply the cells with blood.

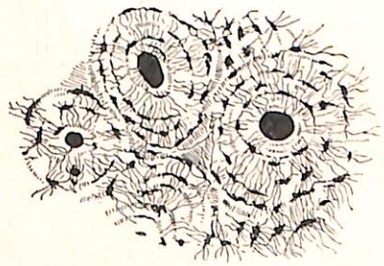
The bones have an inner cavity filled with an oily substance called *marrow*. Job tells us that the marrow moistens the bones. All the bones are covered with a thin membrane, called the *periosteum*. It contains numerous blood vessels, which bring new material to the bones, thus assisting them very much in their growth.



LONGITUDINAL SECTION OF BONE (MAGNIFIED)

Bones are composed largely of two very different substances. One is a mineral compound called *phosphate of lime*. It is hard and brittle. The other is an animal substance, and is very tough. These two substances together make just the right kind of timber for the framework of the temple. Place a bone in the fire, and let the animal matter burn out. Place one in hydrochloric acid, which will dissolve the mineral matter.

The bones of children do not have much mineral matter in them; but as they grow older, more lime is brought into them. In one way this is an advantage; for the ever-falling, tumbling child would soon have broken bones if his bones were as brittle as are those of a full-grown person. But great care must be taken not to distort the bones by wrong positions in sitting and standing.


CROSS SECTION OF BONE (MAGNIFIED)

When a bone has been broken, if the two ends are fitted together, the living cells will make new bone material, and join the broken pieces, making the bone as strong as ever. It is the animal matter alive in the bones that does the work of mending; and as children's bones have much of it,

they are easily repaired. The older a person grows, the less animal matter the bones contain, and the more brittle they become. Old people's bones are easily broken, but difficult to repair.

There are three kinds of joints:—

1. *Hinge Joints.*— Like the hinges of a door, they allow movement in but two directions. Examples: the elbow, and the joints of the fingers.

2. *Ball-and-Socket Joints.*— The round ball-like end of one bone fits into the socket of another bone. Examples: shoulder and hip joints.

3. *Pivot Joints.*— One bone turns around on another bone. The radius of the forearm turns on the end of the humerus. The nodding of the head backward, forward, and sidewise is done by the joint connecting the occipital bone of the cranium with the first vertebra of the spinal column, called the *atlas.* The turning of the head sidewise, as we do in looking in different directions without turning the body, is caused by the atlas vertebra turning on the second vertebra.

The bones at the joints are held in place by strong, tough bands called *ligaments.* There are cartilage pads in the bone joints to lessen the jar in walking, running, and jumping. A liquid secreted by a membrane moistens the surfaces in the joints, and prevents friction.

A *sprain* is caused by stretching some of the ligaments in a joint. They may also be torn. This causes pain, inflammation, and swelling. A severe sprain is more serious than a broken bone, and takes a longer time to heal. In treating a sprain, use first hot water, and then cold water. Rub gently the inflamed portion with the hand, to help the circulation of the blood.

In case a joint is dislocated, the first thing to do is to have the bone brought into its right position. Usually a surgeon's service is needed. Probably some of the ligaments will be torn loose, and inflammation will follow.

I think more people suffer of feet-ache than of headache. The first is usually caused by what they wear, and the second by what they eat. Some people have poor health because they have sick feet. What is the trouble with them? — The patient has worn shoes too tight or too loose, and as a result, is now wearing corns and bunions on the feet. But how does this cause poor health? — In this way: A brisk walk, which quickens the blood circulation, and brings the ruddy glow to the cheek, is not taken when it would cause distress in the feet. Tight shoes also hinder the circulation of the blood, and cold feet result.

A tight shoe deforms the foot by cramping the toes. A healthful shoe has low heels, so that the weight of the body does not crowd the toes. A healthful shoe will not pinch the foot anywhere. Never buy shoes that you would have to "break in" before you could wear them with comfort. If one's shoes hurt his feet, they ought to hurt his conscience too.

The stabilization department bears very great responsibilities. It continually carries the weight of the entire temple; and it aids the locomotion department in moving the temple from place to place as the information department may direct. Let us do all we can to make the living frame strong and stable.

If we would have strong bones, we must have a strong, healthy character. All through the Scriptures we are taught that the mind has a great influence over the body. A sound mind helps greatly to keep the body well. Many people are sick because the mind is corrupted, the conscience condemns them, and the spirit is discouraged. But he who lets the Spirit of God dwell in his body temple, will have a pure mind and a courageous spirit, and his body will be the stronger in consequence.

Questions

1. Who best understands the framework of the human temple? How does this knowledge cause Him to feel toward man?
2. What did David pray that we also should pray? Ps. 39: 4. To what is man's body compared? Ps. 103: 15, 16.

3. What helps to give stability to the human frame?
4. Into what three kinds of material may the body be divided?
5. Name and locate the cranial bones, and state their use.
6. Name and locate the bones of the face. What is the purpose of each? How many bones are there in the head?
7. What are the bones in the trunk? Where is each? What purpose do they serve?
8. Name and locate the bones in the upper limbs. How many bones are there in the arm, the wrist, and the hand?
9. What are the bones of the lower limbs?
10. Describe the microscopic structure of the bones. Describe the marrow and the periosteum.
11. Of what are bones composed? How can this be shown?
12. Explain bone repairing with children and adults.
13. Name and give examples of the three classes of bone joints. Describe ligaments and their use.
14. Describe sprains and dislocations. How should each be treated?
15. How do tight shoes and loose shoes injure the feet?
16. What influence does the mind have on the bones of the body? Prov. 14:30; 15:30; 16:24; 17:22.
17. What encouraging statements are found in the Bible regarding the protection and nourishment of the human frame? Job 10:11; Isa. 58:11.

Note Book Requirement

On page 98 write about the composition and structure of bone.

Lesson LXXIX

The Locomotion Department

(The Muscular System)

But truly I am full of power by the Spirit of the Lord, and of judgment, and of might. Micah 3:8.

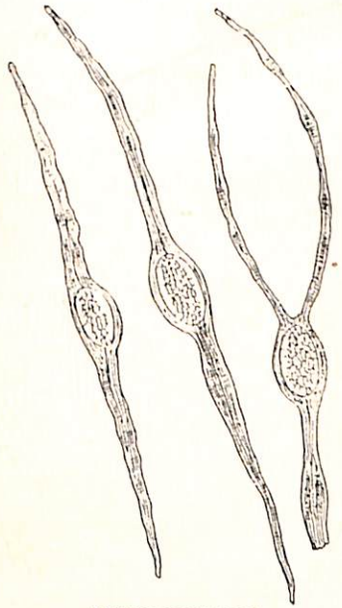
The locomotion department has at its command the power to carry out all orders that come to it from the information

department. It consists of about five hundred muscles distributed throughout the body.

There are two kinds of muscles, each composed of a different kind of cell. The muscles that are controlled with our thought and knowledge are called *voluntary* muscles. Those that are controlled without our thought and knowledge are called *involuntary* muscles. Let us study each of these briefly.

VOLUNTARY MUSCLE FIBER

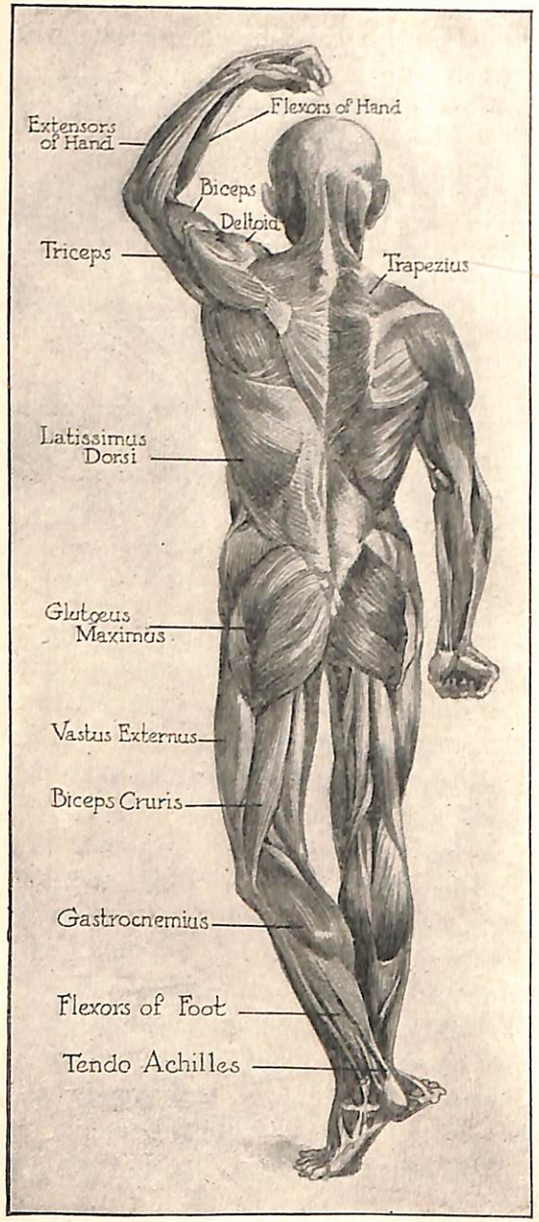
1. *Voluntary Muscles.*— These are the muscles that act at our bidding, as in lifting, walking, and running. Some of these movements we have repeated so many times that we perform them without thinking. These are the muscles that control largely the external organs, as the hands, the arms, the legs, the feet, the mouth, and the eyes. The cells of voluntary muscles have dark stripes running across them. For this reason these muscles are sometimes called *striped* muscles.



INVOLUNTARY MUSCLE FIBER

2. *Involuntary Muscles.*— These are the muscles that do their work without our bidding. The involuntary muscles work the internal organs, as the stomach, and thus relieve the mind of this responsibility. The cells of these muscles are spindle-shaped. They have no stripes running across them, and hence are sometimes called *unstriped* muscles.

Some muscles are attached to bones, either directly, or by tough, elastic bands called *tendons*.



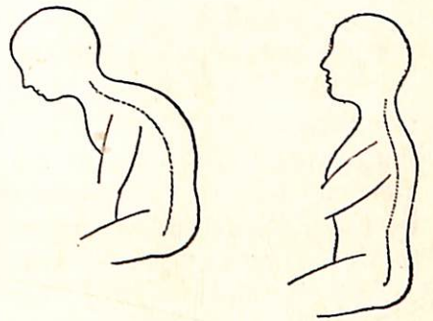
MUSCLES OF THE BODY

Some of the more important muscles are the *ring* muscles of the gullet, the stomach, and the intestines, used in swallowing and churning the food; the *hollow* heart muscle, which forces the blood through the body; the *circular* muscles, used in opening and shutting the eyes and the mouth; the *expression* muscles of the face, used in pouting, frowning, and smiling; the muscle of the *calf of the leg,* used in raising the heel in walking; the *diaphragm* muscle, used in breathing; and the tailor muscle — the longest muscle in the body — used in crossing the legs.

Muscles that bend or flex a limb are called *flexores;* and those that extend a limb, *extensors.* Some muscles are arranged in pairs, each muscle moving the limb in an opposite direction. These muscles are called *antagonists.* The *biceps,* which bends or flexes the arm, and the *triceps,* which straightens it, are

examples of antagonistic muscles. The reason why muscles have to be arranged in pairs, one each side of a limb, as in the arm and the leg, is that muscles can not push. They can pull only, and this they do by contracting.

There are about three hundred voluntary muscles, some large and some small, some short and some long. We shall not give the names of other muscles; for some of these names are very long, difficult to pronounce, and hard to remember. In the illustration, the names of some of the more important muscles on the outside of the body are given. It is far more important to learn how to use the muscles, and how to treat them in such a way that they will render the greatest service to us, than it is to learn their names.



EFFECT OF IMPROPER POSTURES

The dotted lines represent the backbone.

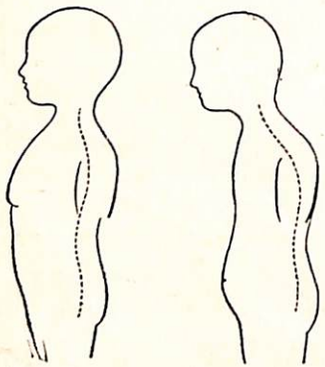
Muscles are not a mere ornamentation to the body. They were made to work. It is true that the muscles give grace and beauty to the form. They cover the bones, and fill their hollows and crevices, producing graceful curves, and giving plumpness to the figure. But muscles that do not work, shrivel away. Therefore if we desire to have a plump, rounded form, we must exercise the muscles every day. One of the laws pertaining to the locomotion department is, "What is not used, can not be kept." Those who do not use their muscles, find them gradually shrinking away, until only a little weak, flabby flesh is found where there ought to be well-rounded muscles.

Notice the young lamb, colt, and kitten. How lively and frisky they are! They enjoy exercise, and it makes them grow. The Creator gave them the spirit of play and frolic. He has given the same spirit to young boys and girls; and daily, in the open air, they should run, jump, and exercise their muscles until

they can feel the blood tingling in every part of the body. While it is true that "all work and no play makes a dull boy," it is also true that all play and no work makes a lazy boy. A part of each day should be spent in helping father or mother, brother or sister, in doing the work about the home. We must learn to love our work as well as our play.

In these days when there are so many riding vehicles,— steam cars, electric cars, and automobiles,— there is very little walking done; and yet it is one of the best of exercises. We should not ride except when it is necessary. Save the street car fare when the distance is not too great. You can make a better use of the money, and you will have better health. In the days before we had all these conveniences for riding, the people generally had to walk, and carry loads in their arms or on their backs. But they had better health.

If we are not careful, all the modern conveniences — upholstered furniture, gas and electric heaters and cookers, and many other luxuries — will be a curse to us instead of a blessing. Do you ask how this can be? These conveniences save hard work, which would furnish excellent exercise, and strengthen the body. The effort of inventors all the time is to save labor, when labor is a great blessing, and idleness is a great curse. Whatever the comforts of the home, we should exercise each day sufficiently to start a good perspiration. "In the sweat of thy face shalt thou eat bread, till thou return unto the ground." This sweating is to be caused by work, and not by play. A great evil is in the world to-day in the many games and sports that are carried on. We should have some innocent recreation; but the match games of ball and other plays are rough and cruel, and many lives are lost each year by the



EFFECT PRODUCED BY IMPROPER POSTURES

The dotted lines represent the backbone.

efforts made to "beat" in the games. Life and limbs, time and energy, are too precious to spend in selfish, useless games.

We must not become so interested in our studies that we shall neglect daily physical exercise. We shall have clearer minds if we use our muscles. This calls the blood away from the brain, and gives the brain a chance to rest.

We should be careful, in our work and recreation, to employ all the muscles. If we exercise only part of the muscles, our bodies will not present a good appearance. One of the worst and yet most common defects is "round shoulders." A person with round or stooped shoulders causes others to feel that he does not have strength enough to hold his shoulders back, and that he has no more strength of character than of body.

Here are the directions for developing a good carriage: Chest forward, hips back, and chin in. Using hammocks and reclining chairs, and leaning against supports when standing, develops a weak, ill-shaped figure.

Questions

1. How many kinds of muscles has the body? Explain the work of each. Describe the structure of each.
2. Name some of the more important muscles, and the work done by each. How many voluntary muscles are there in the body?
3. What are flexor, extensor, and antagonistic muscles? Give examples of each.
4. In what ways should the muscles be exercised? What kind of exercise is the most beneficial?
5. What influence are the conveniences and luxuries of life having on the health of the body? Why?
6. What relation does exercise of the muscles have to mental activity?
7. What is the cause of "round shoulders" and "hollow chest"?
8. Give the recipe for erect position and carriage.

Note Book Requirement

On page 100 name and describe the most important muscles of the body.

Lesson LXXX

The Temple Defiled

If any man defile the temple of God, him shall God destroy; for the temple of God is holy, which temple ye are. 1 Cor. 3: 17.

This wonderful, sacred temple which we have been studying is to be kept holy and undefiled. It is just as sacred as were the tabernacle and the temple of old. God not only instructed Israel that the buildings erected by His command were holy structures, but He taught them that their bodies were holy, and should not be defiled. This was written in the book of the laws of Moses: "I am the Lord your God: ye shall therefore sanctify yourselves, and ye shall be holy; for I am holy: neither shall ye defile yourselves." Another law in the same book, with reference to man's eating, says, "He shall not eat to defile himself."

The body temple may be defiled in many ways; but in this study, let us consider how it is defiled by eating and drinking those things which do not nourish the body, but weaken it. Only that which will build up the body can be called food. That which weakens the body and destroys the tissues is poison. Some of the things that many people eat and drink to-day, and call foods, are in reality poisons. They are slow-acting poisons, and for that reason people are deceived as to the harm done by them. If they were quick-acting poisons, like strychnine and morphine, there would be less harm done, for they would be let alone. But these slow poisons are doing their deadly work, and in time the body temple is not only defiled but destroyed.

The most widespread habits which injure and destroy the body, are the drinking of alcoholic liquors, tea, and coffee, and the smoking and chewing of tobacco. These poisons are called *stimulants* and *narcotics,* because the stimulants stimulate or excite the tissues and organs of the body, and the narcotics benumb them. "Stimulant" comes from a Latin word meaning

"whip." Stimulants, when taken into the body, excite the cells and tissues, and cause them to overwork, just as a whip causes a horse to overwork. But the whip makes a poor, weak, lazy horse, while oats make a fat, strong, lively horse. Many people are using tea-and-coffee whips to make them stronger, but they can thrive no better on whips than can a horse.

Narcotics — alcoholic drinks and tobacco — are thought to be stimulating in their effect; but on the contrary, they are paralyzing. For a little time, one may feel enlivened; but afterward there is a stupid, depressed feeling.

The best way to determine the character of a man is by what he does. "By their fruits ye shall know them." This is just as true of things as of men. Let us examine each of these pretended foods, and see what kind of deeds they perform in the body, and how they influence the mind and the morals.

Alcohol.— Place the white of an egg in a tumbler of alcohol, and in a short time it is cooked. This is the effect alcohol has on the tissues of the body. It paralyzes them, hindering their active service in the body. All the wines and liquors produce this effect on the tissues, for they all contain alcohol. Many of the drugs that mothers give to their children to quiet them contain alcohol or other poisons, and thus early in life the children acquire an appetite for these things.

Alcoholic drinks redden the skin. The skin of the drinker is often flushed. The eyes of the toper appear bloodshot, and the nose is purple.

Alcohol affects the cerebrum of the brain first, making the drinker talk foolishly; then it attacks the cerebellum, causing him to stagger; and finally it acts on the medulla, producing hard breathing and drunken stupor. Alcohol weakens the blood vessels in the lungs, and makes them very receptive to congestive diseases like pneumonia. Not only the blood vessels in the lungs are affected, but those all over the body are weakened. Alcohol weakens the muscles; and men are much stronger who drink pure water only. It also weakens the cells of the bones. This

is proved by the long time required for the broken bones of a drunkard to grow together. All this testimony from the cells and tissues of the body is against alcohol, instead of in its favor. It is a destroyer of cell and tissue, not a nourisher and builder.

How does the drink habit affect the mind and the morals? "A sound mind in a sound body," we have learned, is one of the laws of our being. Since alcohol breaks down the body, it must break down the character. In hinders rapid and clear thought. It destroys the judgment. It makes the drinker shiftless and dishonest. His family suffer for want of food and clothing, and feel ashamed and disgraced.

Tobacco.— This weed contains a violent poison called *nicotine.* Chemists say that in one cigar there is enough nicotine to kill two men, if taken into the blood circulation. One drop of it will kill a dog. Of course cigars and cigarettes are so made that the poison is dealt out very slowly, but the final results are the same. Tobacco weakens the nerves, stupefies the brain, hinders digestion, destroys the appetite, and interferes in many ways with the working of the various departments of service. Tobacco causes irregular heart beating, thus preventing the normal circulation of the blood. It causes weakness of the eyes, and irritates the mucous linings of the mouth and the throat. The first effort to use tobacco makes most boys sick, which shows that God never intended it to be used as food by man.

The use of cigarettes by young boys is a very serious evil. It stunts the growth, benumbs the brain, weakens the lungs, and in a short time robs the boy of all that is manly. The tobacco habit leads to the liquor habit; and with these go card playing, gambling, and all kinds of vice and sin.

As with alcohol, so with tobacco,— all the evidence is against its character. Alcohol and tobacco are twin companions, that are working ruin wherever they go. The whisky drinker and the tobacco user pollute the air that others breathe. The using of

tobacco is a very filthy habit; and instead of indicating manliness, it indicates just the opposite.

Tea and Coffee.— These two stimulating drinks are very generally used, but both of them contain poison. While tea and coffee are much less harmful than alcohol and tobacco, yet they are very injurious to the health. For a time, they enliven the action of the cells and tissues of the body; yet, like the whip on the horse's back, they cause overwork for a brief period, and then the body relaxes, more exhausted than ever.

Pure cold water is the only beverage that God provided man. It is all-sufficient. If one needs a hot drink, hot water or hot milk can be used. Hot fruit juices also are good. The only stimulation we need is such as is provided in good, substantial food.

Tea and coffee give no nourishment to the body, but cause it to overwork, and thus borrow energy that should be reserved for future use. The habit of tea and coffee drinking we must condemn along with the drinking of liquors and using tobacco. While it is not so serious in its results, yet it prepares the way for the use of the stronger narcotics.

One of the strongest testimonies against all these energy wasters and body destroyers, is that they create in the body a craving for their presence and use. The habit of using them is quickly formed and very difficult to break. Many persons who are slaves to the use of alcoholic drinks and tobacco, are longing for deliverance, but say they can not let them alone. This is also true of tea and coffee drinkers. But there is deliverance for all who will yield their bodies to be temples for the indwelling of God's Holy Spirit.

Since alcohol, tobacco, tea, and coffee are not foods, what an immense amount of money is spent for that which is worse than nothing! Let us exert our influence against the use of all stimulants. Let us be an example to others in our habits of eating and drinking.

There are other things that are not food, which we should discard. The condiments, such as vinegar, mustard, and pepper, are used to create an appetite. They increase slightly the flow of the digestive fluids; but they give no nourishment or energy to the body. Instead, they deaden the nerves if used in considerable amounts. If we have no appetite, the stomach undoubtedly needs a rest, and should not be urged to work when it has already been overtaxed.

The taking into our bodies of all these things that are not foods, to satisfy our perverted appetites, is defiling the temple of God. The temple can be defiled in other ways besides in eating and drinking. It can be defiled by speaking evil words and thinking impure thoughts. Are you allowing your temple to be defiled in these ways? Remember, "If any man defile the temple of God, him shall God destroy." Also remember the words of David, "Blessed are the undefiled in the way, who walk in the law of the Lord."

Questions

1. What did the Lord teach the people of Israel about defiling their bodies? Lev. 11:44; 22:8.
2. In what ways can the body be defiled?
3. What is a food? What is a poison?
4. What are narcotics and stimulants? Give examples of each.
5. How does alcohol affect the body? What drinks contain alcohol?
6. What does God say about those who use strong drink? Prov. 20:1; 23:29-32.
7. In what ways is tobacco used? Describe its effects on the body.
8. What two stimulants are widely used as beverages? Describe their effects on the body.
9. What besides stimulants and narcotics are generally used that are not food? What damage do they do?
10. What is the penalty those suffer who defile their bodies?
11. What did David say of the man who was undefiled?

Lesson LXXXI

The Temple Cleansed

Hear me, ye Levites, sanctify now yourselves, and sanctify the house of the Lord God of your fathers, and carry forth the filthiness out of the holy place. 2 Chron. 29:5.

These are the words of Hezekiah, king of Judah, who called upon the Levites to cleanse the temple. The temple had been defiled, and they were commanded to carry the filthiness out of the holy place. The record says that the Levites gathered themselves together, "and sanctified themselves, and came, according to the commandment of the king, by the words of the Lord, to cleanse the house of the Lord. And the priests went into the inner part of the house of the Lord, to cleanse it, and brought out all the uncleanness that they found in the temple of the Lord into the court of the house of the Lord. And the Levites took it, to carry it out abroad into the brook Kidron." The Israelites had forsaken the temple, and had shut its door. The filthiness was that which had accumulated while the temple was neglected. Sixteen days were spent by the priests and the Levites in doing the work of cleansing the house of God.

When Christ was on earth, He was greatly displeased as He saw how the temple at Jerusalem was defiled. Twice during His ministry He cleansed it.

These instances show that God wanted the temple buildings to be kept holy, and also that He was willing to cleanse them when they became defiled. Christ's cleansing the temple twice, showed how willing He was to cleanse their bodies. As He had power to cleanse the temple building, He also has power to cleanse the temple body. Whatever the filth may be, He can cleanse it away. Some, perhaps, have untidiness in their homes, which needs to be cleansed away with soap and water and a brush. Others may have neglected to maintain proper habits of bathing the body. The accumulated waste from the pores of the

skin becomes filth if allowed to remain. Still others may be causing wastes to accumulate in the body temple by overeating; and as a result, the system is filled with impurities that the body finds it difficult to get rid of through the elimination department.

Then there is that large class who have allowed appetite to control them so far that they have taken into the body temple things which should have no place there, and now it is very difficult to remove these things, and say, "Get thee hence." But there is deliverance for all, if the Christ who cleansed the temple of wood and stone, is, by His Holy Spirit, allowed admittance into these temples of flesh. He will take away these perverted appetites, and give us new appetites, for wholesome food; and thus the buyers and the sellers and the money changers will be cast out of these temples. The buying and selling begins in our body temples when our minds consent to the cravings of appetite, and then we patronize those whose business it is to take our money in exchange for that which destroys our bodies and our souls.

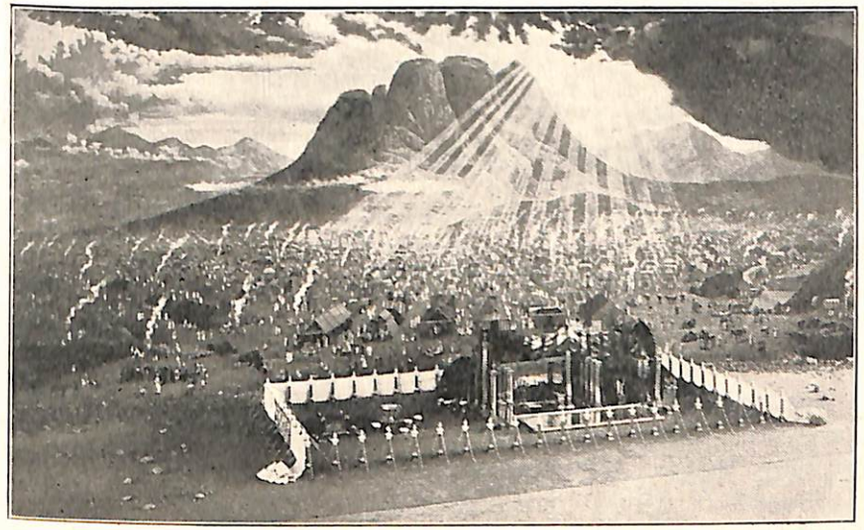
Let us not forget that all uncleanness must be taken outside the temple,— not only the filthiness of the flesh, but also that of the mind. Filthy words and filthy thoughts are far worse than a filthy home and a filthy body.

"Let us cleanse ourselves from all filthiness of the flesh and spirit, perfecting holiness in the fear of God."

Questions

1. Describe the cleansing of the temple that was carried forward by the command of Hezekiah, king of Judah. Why did the temple need cleansing? 2 Chron. 29:5, 15, 16.
2. Describe the first cleansing of the temple by Christ. John 2:13-16.
3. When did the second cleansing take place? From what was the temple cleansed the second time? Matt. 21:12, 13.
4. Why did the Saviour cleanse the temple? Why did He cleanse it twice?

5. What lesson can we learn from the cleansing of the temple of wood and stone, that will help us to understand better the cleansing of the temples of flesh?
6. What defilement needs to be removed from the courts of these body temples? How can this purifying be done?
7. What needs to be removed from the outside of these temples? How may it be removed?
8. What need to be removed from the inside of the temple?
9. What wonderful promises do the Scriptures contain for those whose temples are defiled? Eze. 36:25; Zech. 3:3, 4; 2 Cor. 7:1; 1 Peter 1:3-5.
10. What kind of inheritance is now reserved for those who are fully cleansed from all defilement?



CHAPTER XII

THE SABBATH

(Scripture Basis, Gen. 2:1-3)

"The Sabbath was made for man, and not man for the Sabbath."

Lesson LXXXII

Physical and Spiritual Rest

Six days shall work be done: but the seventh day is the Sabbath of rest, an holy convocation; ye shall do no work therein: it is the Sabbath of the Lord in all your dwellings. Lev. 23:3.

We have found, in our study of man's body, that it has been weakened by sin and transgression, and that periods of rest are necessary. When God gave to our first parents the Sabbath in Eden, it was that they might have time to commune with their Maker, and meditate on His power, wisdom, and love as revealed in His wonderful works. They did not need the Sabbath then to give rest to body or mind, for they did not become weary of work or study. The Sabbath was a day to worship the Creator; and all work was laid aside, that nothing should interrupt their communion with Him.

But sin has brought about a great change. Now the Sabbath is not only a day for worship, but it affords opportunity to rest body and mind, as well as to refresh the spirit.

The Sabbath rest gives relief from the labor of the week. But the Sabbath is not to be spent in idleness. It should not be spent in sleep. While we lay aside our work, yet we are to be active. The change from common physical labor, and the exercise in spiritual things, bring rest to body and mind.

The Sabbath day gives rest not only to mind and body, but also to weary, troubled souls. On this day we are free from the toil of the week, and we can draw nearer to God than we can when our minds and hands are occupied with work. But at all times the Saviour extends to His children the blessed invitation: "Come unto Me, all ye that labor and are heavy-laden, and I will give you rest. Take My yoke upon you, and learn of Me; for I am meek and lowly in heart: and ye shall find rest unto your souls. For My yoke is easy, and My burden is light."

The presence of the Holy Spirit will give us rest, as the Lord said to Moses: "My presence shall go with thee, and I will give thee rest." "The Spirit of the Lord caused him to rest." David gives this excellent counsel: "Rest in the Lord, and wait patiently for Him."

We can find rest in the Lord every day in the week; but on the Sabbath, we shall find the fullest rest, for it is God's holy rest day. We can then study the word and works of God. Both declare His great wisdom, power, and goodness.

"God designs that the Sabbath shall direct the minds of men to the contemplation of His created works. Nature speaks to their senses, declaring that there is a living God, the Creator, the Supreme Ruler of all. . . . The beauty that clothes the earth is a token of God's love. We may behold it in the everlasting hills, in the lofty trees, in the opening buds and the delicate flowers. All speak to us of God. The Sabbath, ever pointing to Him who made them all, bids man open the great

book of nature, and trace therein the wisdom, the power, and the love of the Creator."

"On the holy rest day, above all other days, we should study the messages that God has written for us in nature. We should study the Saviour's parables where He spoke them, in the fields and groves, under the open sky, among the grass and flowers. As we come close to the heart of nature, Christ makes His presence real to us, and speaks to our hearts of His peace and love."

Let us spend the Sabbath so we can enjoy all the blessings it brings to us. If we give our bodies, minds, and hearts to God, they will become pure and holy, and then we shall not profane the Sabbath day. Though we may become weary and troubled at times, if faithful and true to God we shall find a home in a land where all is peace and quietness. Job says concerning it, "There the wicked cease from troubling; and there the weary be at rest."

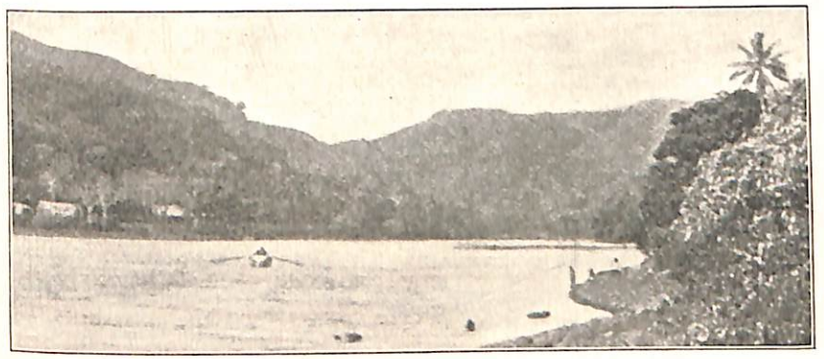
That place will be our home in the new earth. There we shall still keep the holy Sabbath that we have learned to keep while here. On that day we shall all gather to worship before the throne of God. The prophet Isaiah, speaking of these Sabbath meetings, says, "And it shall come to pass, that from one new moon to another, and from one Sabbath to another, shall all flesh come to worship before Me, saith the Lord."

Let us learn to keep the Sabbath here, that we may have the happy privilege of attending those glorious Sabbath meetings around the throne of God.

Questions

1. What influence has sin had on man's body?
2. What is necessary to keep the body well and strong?
3. What provision did God make in Eden that now gives opportunity for rest?
4. Was the Sabbath made to give opportunity for physical and mental rest? For what purpose was it made?
5. What invitation to rest does the Saviour give to those who are weary? Matt. 11:28-30.

6. What does the presence of God's Spirit give to those who allow it to dwell in them? Ex. 33:14; Isa. 63:14.
7. Is the rest given by the Spirit of God confined to any particular day? Upon what day is it given most abundantly? Why?
8. How are we to spend the holy hours of the Sabbath?
9. What benefits will be derived from the study of nature on the Sabbath day?
10. If we learn how to keep the Sabbath on earth, what privilege will we have in the new earth?
11. Will there be any weariness or perplexity there?



CHAPTER XIII

THE FALL OF MAN

(Scripture Basis, Genesis 2 and 3)

"Rejoice not against me, O mine enemy: when I fall, I shall arise."

Lesson LXXXIII

"Great Was the Fall"

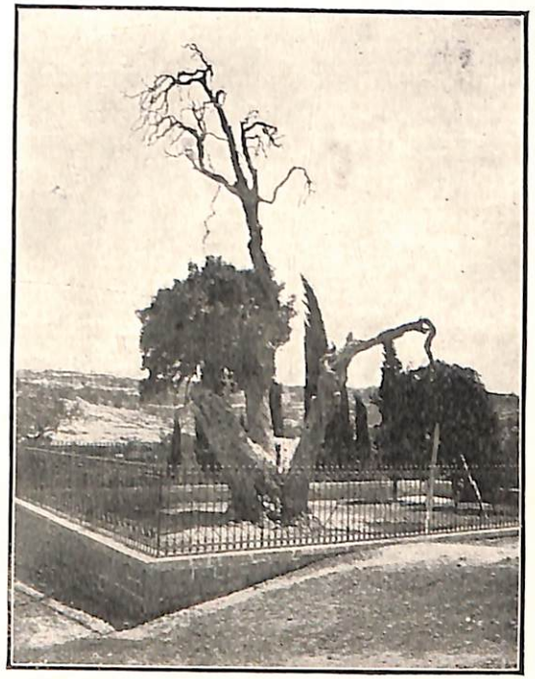
How are the mighty fallen! 2 Sam. 1:25.

These are the words of David when he wept over Saul, king of Israel, and over his son Jonathan. Saul was slain because he disobeyed God, and his son suffered because of the father's transgression.

But the first mighty being that fell because of disobedience was Lucifer. He lost his exalted position in heaven, and was cast to the earth. His fall is described by the prophet Isaiah: "How art thou fallen from heaven, O Lucifer, son of the morning! how art thou cast down to the ground, which didst weaken the nations!"

When Lucifer changed his character, God changed his name, and called him *Satan.* Many of the angels lost heaven through

his influence. Since Satan's fall, it has been his constant effort to cause the downfall of the mighty rulers of earth and their subjects. First he tempted Adam, the ruler of the earth, and Eve, his companion, causing their fall from the high station that God designed they should occupy. The sons and daughters of Adam and Eve have been subjected constantly to his artful temptations, and have fallen "into many foolish and hurtful lusts, which drown men in destruction and perdition."



ABRAHAM'S OAK

Testifying of results of sin upon the plant kingdom

Christ, speaking of Satan's character and work, said: "He was a murderer from the beginning, and abode not in the truth, because there is no truth in him. When he speaketh a lie, he speaketh of his own: for he is a liar, and the father of it."

After Satan has had control of his subjects for thousands of years, the prophet gives the following description of their fallen condition: "Judgment is turned away backward, and justice standeth afar off: for truth is fallen in the street, and equity can not enter. Yea, truth faileth; and he that departeth from evil maketh himself a prey: and the Lord saw it, and it displeased Him that there was no judgment." This scripture shows how great has been man's fall from the holy station he occupied when he was created in the image of God.

In all our study of God's creation, we have seen here and there the trail of the serpent that caused the fall of man. Thorns and thistles, annoying pests, wild and ferocious beasts, famines and earthquakes, all tell how great and terrible are the results of sin. But man is the greatest sufferer. His life has been shortened, his body weakened, and his heart corrupted, so that the image of his Maker is nearly effaced.

Violence and wickedness fill the earth; and if time were to last a few more hundred years, the human family would come to an end without God's destroying them. By intemperance man would bring upon himself diseases of all kinds, which would weaken body and mind, and cause multitudes to pass away in a short time. Even now infectious and contagious diseases are destroying men, women, and children in great numbers. This tells us how great and dreadful was the fall of man.

The greatness of his fall can only be measured by the greatness of the price paid to restore and redeem him from his fallen condition. What did this redemption cost? — It required the life of the only Son of God.

"The fall of man filled all heaven with sorrow. The world that God had made was blighted by the curse of sin, and inhabited by beings doomed to misery and death. There appeared no escape for those who had transgressed the law. Angels ceased their songs of praise. Throughout the heavenly courts there was mourning for the ruin that sin had wrought.

"The Son of God, heaven's glorious Commander, was touched with pity for the fallen race. His heart was moved with infinite compassion as the woes of the lost world rose up before Him. But divine love had conceived a plan whereby man might be redeemed. The broken law of God demanded the life of the sinner. In all the universe there was but one who could, in behalf of man, satisfy its claims. . . . None but Christ could redeem fallen man from the curse of the law, and bring him again into harmony with Heaven. . . .

"Before the Father He pleaded in the sinner's behalf, while the host of heaven awaited the result with intensity of interest that words can not express. Long continued was that mysterious communing,—'the counsel of peace' for the fallen sons of men. . . . The plan of salvation had been laid before the creation of the earth; . . . yet it was a struggle, even with the King of the universe, to yield up His Son to die for the guilty race. But 'God so loved the world, that He gave His only-begotten Son, that whosoever believeth in Him should not perish, but have everlasting life.' O, the mystery of redemption! The love of God for a world that did not love Him! . . .

"The angels could not rejoice as Christ opened before them the plan of redemption; for they saw that man's salvation must cost their loved Commander unutterable woe. In grief and wonder they listened to His words as He told them how He must descend from heaven's purity and peace, its joy and glory and immortal life, and come in contact with the degradation of earth, to endure its sorrow, shame, and death. . . .

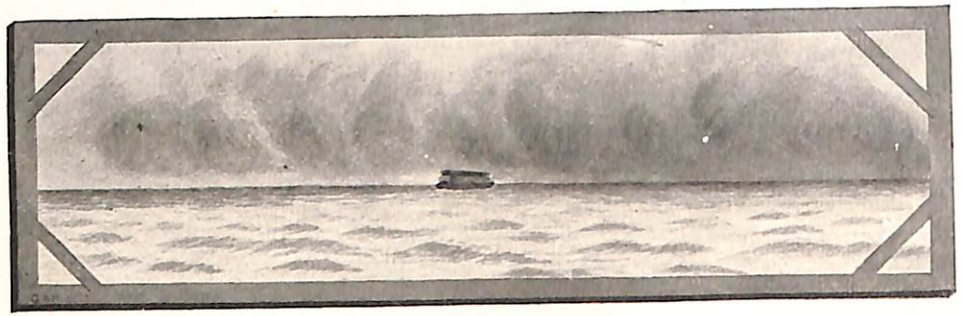
"The angels prostrated themselves at the feet of their Commander, and offered to become a sacrifice for man. But an angel's life could not pay the debt; only He who created man had power to redeem him. Yet the angels were to have a part to act in the plan of redemption. . . .

"He bade the angelic host to be in accord with the plan that His Father had accepted, and rejoice that, through His death, fallen man could be reconciled to God. Then joy, inexpressible joy, filled heaven. The glory and blessedness of a world redeemed, outmeasured even the anguish and sacrifice of the Prince of Life. Through the celestial courts echoed the first strains of that song which was to ring out above the hills of Bethlehem,—'Glory to God in the highest, and on earth peace, good will toward men.' With a deeper gladness now than in the rapture of the new creation, 'the morning stars sang together, and all the sons of God shouted for joy.' "

CHAPTER XIV

THE FLOOD

(Scripture Basis, Genesis 6 to 9)



"Behold, I, even I, do bring a flood of waters upon the earth."

Lesson LXXXIV

The Witness of the Flood

For this they willingly are ignorant of, that by the word of God the heavens were of old, and the earth standing out of the water and in the water: whereby the world that then was, being overflowed with water, perished. 2 Peter 3: 5, 6.

The patriarch Job long ago said, "Speak to the earth, and it shall teach thee." Those who are willing to be taught by the writings or impressions that the flood has made upon the rocks and soils of the earth will learn many wonderful things. Rocks, mountains, plant and animal fossils, all bear silent witness to the truthfulness of the Bible record of a flood. The fossils teach us that plants, animals, and man have decreased in size, under the curse of sin.

Bones of animals much larger than any now living, or that have lived in thousands of years, have been discovered. On account of this, some scientists have thought that animals must have been on the earth long before man was created. But the Scriptures make it all plain in the light of the flood and the degenerating power of sin.

In the days of Noah, men and animals many times larger than any that now exist were buried, and have in this way been preserved to furnish proof that the Bible is a book of truth. God intended that the discovery of these fossils and relics should strengthen our faith in the word of God, which is the most ancient history we possess. The following is a vivid description of what took place at the time of the flood:—

THE FLOOD

"The entire surface of the earth was changed at the flood. A third dreadful curse rested upon it in consequence of sin. As the waters began to subside, the hills and mountains were surrounded by a vast, turbid sea. Everywhere were strewn the dead bodies of men and beasts. The Lord would not permit these to remain to decompose and pollute the air, therefore He made of the earth a vast burial ground. A violent wind which was caused to blow for the purpose of drying up the waters, moved them with great force, in some instances even carrying away the tops of the mountains, and heaping up trees, rocks, and earth above the bodies of the dead. By the same means the silver and gold,

the choice wood and precious stones, which had enriched and adorned the world before the flood, and which the inhabitants had idolized, were concealed from the sight and search of men, the violent action of the waters piling earth and rocks upon these treasures, and in some cases even forming mountains above them. . . .

FOSSIL BIRD TRACK

"The earth presented an appearance of confusion and desolation impossible to describe. The mountains, once so beautiful in their perfect symmetry, had become broken and irregular. Stones, ledges, and ragged rocks were now scattered upon the surface of the earth. In many places, hills and mountains had disappeared, leaving no trace where they once stood; and plains had given place to mountain ranges. These changes were more marked in some places than in others. Where once had been earth's richest treasures of gold, silver, and precious stones, were seen the heaviest marks of the curse. And upon countries that were not inhabited, and those where there had been the least crime, the curse rested more lightly.

FOSSIL LEAVES

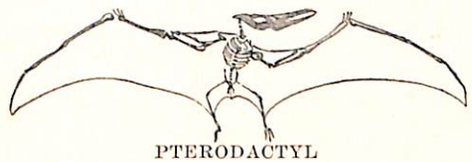
"At this time immense forests were buried. These have since been changed to coal, forming the extensive coal beds that now exist, and also yielding large quantities of oil. The coal and oil frequently ignite and burn beneath the surface of the earth. Thus rocks are heated, limestone is burned, and iron ore melted. The action of the water upon the lime adds fury to the intense heat, and causes earthquakes, volcanoes, and fiery issues. As the fire and water come in contact with ledges of rock and ore, there are heavy explosions underground, which sound like muffled thunder. The air is hot and suffocating. Volcanic eruptions follow; and these

often failing to give sufficient vent to the heated elements, the earth itself is convulsed, the ground heaves and swells like the waves of the sea, great fissures appear, and sometimes cities, villages, and burning mountains are swallowed up."

We can now clearly see how the precious stones and metals, the vegetation, and the animals were buried beneath the surface of the earth. We also learn what causes the commotion and disturbance in the interior of the earth. The above description is all in harmony with the word of God, and therefore is the true explanation of conditions we find in the earth.

BRONTOSAURUS

In the beginning, "the trees far surpassed in size, beauty, and proportion any now to be found; their wood was of fine grain and hard substance, closely resembling stone, and hardly less enduring." On this account it would be readily turned into coal, or preserved in a petrified condition. Even leaf imprints have been found on the rocks.



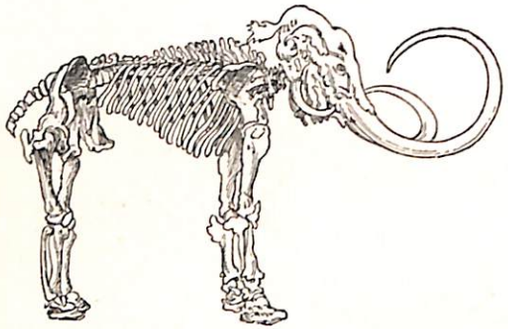
PTERODACTYL

We have already spoken of the large fossil skeletons of the elephantlike animal, the *mastodon;* the slothlike giant, the *megatherium;* and the whalelike creature, the *zeuglodon.* Many other giant fossils have been found, and placed in the great museums of different countries.

The reptilelike monsters were not confined to the land and water. A very large flying reptile called the *pterodactyl* — meaning *wing-fingered,* like a bat — was probably a terror to all the air animals. This huge birdlike reptile had very large eyes, and probably, like the bat, was a nocturnal creature. When its wings were outspread, they would measure twenty feet from tip to tip.

Some idea of the enormous size of these extinct serpentlike monsters has been gathered by a study of the footprints that have been preserved in the solid rocks, as well as by their skeletons.

Among the largest animals living before the flood were the *dinosaurs* — a word which means "terrible lizards." Some of this family had the appearance of lizards, while others did not.



MAMMOTH

The dinosaur called *diplodocus* had a kangaroolike appearance, having small forelegs and very large hind legs and a very long tail. The neck was twenty feet in length, the upright body twenty feet, and the tail forty feet, making a gigantic creature not less than eighty feet from its head to the tip of its tail. When this great lizard stood upright on its hind legs and its tail, its head must have been about forty-five feet above the ground. Its head was no longer than that of a horse, and its brain was about the size of a walnut. The fossils of these mighty animals have been found scattered over the world, but they are most abundant in the United States, in Wyoming, Montana, and Colorado.

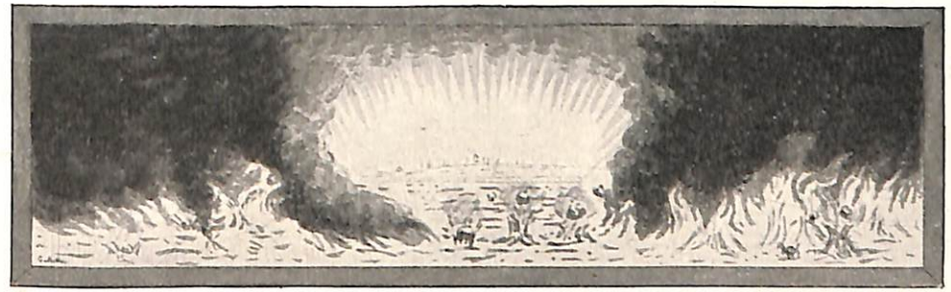
Other very large animals, resembling the hippopotamus and the rhinoceros, lived before the flood, and many of their skeletons have been found in western United States, especially in the "Bad Lands" of the Dakotas.

Another very large fossil is that of the *brontosaurus,* which had a body about eighty feet long.

CHAPTER XV

THE FINAL DESTRUCTION

(Scripture Basis, 2 Peter 3:3-14)



"The heavens and the earth, which are now, . . . are kept in store, reserved unto fire."

Lesson LXXXV

The Great Day of Destruction

Where are the dwelling places of the wicked? Have ye not asked them that go by the way? and do ye not know their tokens, that the wicked is reserved to the day of destruction? they shall be brought forth to the day of wrath. Job 21:28-30.

The time when the wicked shall be destroyed is often mentioned in the Bible. It is called the "day of wrath," "day of darkness," "day of gloominess," and "day of destruction." The word of God dwells mostly on the love and mercy of God; but it also speaks of His wrath. Those who refuse to accept His offers of love and mercy will be visited by His anger. If this were not done, then sin would always exist, and suffering and misery would never end.

We can not imagine how dreadful the day of final destruction will be; but by the earthquakes, volcanoes, and storms, we can form some idea of what it will be. Yet while it will be a terrible day for the wicked, it will be a day of joyful deliverance for the righteous.

The wicked who are living at the time of Christ's second coming will be consumed by "the spirit of His mouth," and destroyed by "the brightness of His coming." But their final destruction does not take place till a thousand years later. Fire and brimstone are the agencies used for that work, and for purifying and cleansing the earth.

MESSINA EARTHQUAKE RUINS

The prophet Isaiah gives this description of that time: "For it is the day of the Lord's vengeance, and the year of recompenses for the controversy of Zion. And the streams thereof shall be turned into pitch, and the dust thereof into brimstone, and the land thereof shall become burning pitch."

Concerning that time Malachi says: "For, behold, the day cometh, that shall burn as an oven; and all the proud, yea, and all that do wickedly, shall be stubble: and the day that cometh shall burn them up, saith the Lord of hosts, that it shall leave them neither root nor branch. But unto you that fear My name shall the Sun of Righteousness arise with healing in His wings; and ye shall go forth, and grow up as calves of the stall. And ye shall tread down the wicked; for they shall be ashes

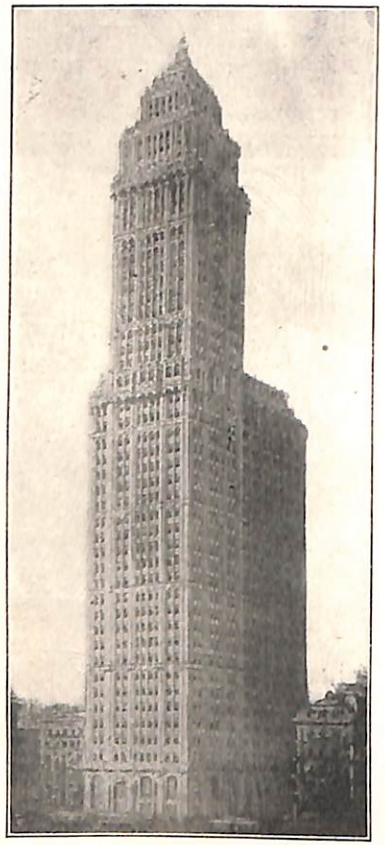
under the soles of your feet in the day that I shall do this, saith the Lord of hosts."

Thus we see that the destruction of sinful men and their works will be complete. All will be burned, and nothing remain but ashes. This will not only be true of men and their sinful works; but it will also be true of Satan, the author of sin. He, too, as the prophet Ezekiel testifies, will be brought to ashes. "I will destroy thee, O covering cherub, from the midst of the stones of fire. Thine heart was lifted up because of thy beauty, thou hast corrupted thy wisdom by reason of thy brightness: I will cast thee to the ground, I will lay thee before kings, that they may behold thee. Thou hast defiled thy sanctuaries by the multitude of thine iniquities, by the iniquity of thy traffic; therefore will I bring forth a fire from the midst of thee, it shall devour thee, and I will bring thee to ashes upon the earth in the sight of all them that behold thee. All they that know thee among the people shall be astonished at thee: thou shalt be a terror, and never shalt thou be any more."

"Satan's work of ruin is forever ended. For six thousand years he has wrought his will, filling the earth with woe, and causing grief throughout the universe. The whole creation has groaned and travailed together in pain. Now God's creatures are forever delivered from his presence and temptations. 'The whole earth is at rest, and is quiet: they [the righteous] break forth into singing,' and a shout of praise and triumph ascends from the whole loyal universe. 'The voice of a great multitude,' 'as the voice of many waters, and as the voice of mighty thunderings,' is heard, saying, 'Alleluia; for the Lord God omnipotent reigneth.'

"While the earth was wrapped in the fire of destruction, the righteous abode safely in the holy city. Upon those that had part in the first resurrection, the second death has no power. While God is to the wicked a consuming fire, He is to His people both a sun and a shield.

"'And I saw a new heaven and a new earth: for the first heaven and the first earth were passed away.' The fire that consumes the wicked purifies the earth. Every trace of the curse is swept away."



AN EXAMPLE OF MAN'S WORK IN BUILDING

"There came a great voice out of the temple of heaven, from the throne, saying, It is done. And there were voices, and thunders, and lightnings; and there was a great earthquake, such as was not since men were upon the earth, so mighty an earthquake, and so great. And the great city was divided into three parts, and the cities of the nations fell: and great Babylon came in remembrance before God, to give unto her the cup of the wine of the fierceness of His wrath. And every island fled away, and the mountains were not found." Rev. 16: 18-20.

"And the nations were angry, and Thy wrath is come, and the time of the dead, that they should be judged, and that Thou shouldest give reward unto Thy servants the prophets, and to the saints, and them that fear Thy name, small and great; and shouldest destroy them which destroy the earth." Rev. 11: 18.

Note Book Requirement

Write in your own words, upon page 111, a description of the earth's final destruction.

CHAPTER XVI

THE NEW EARTH

(Scripture Basis, Revelation 21 and 22)

"The first heaven and the first earth were passed away; and there was no more sea."

Lesson LXXXVI

Created Not in Vain

He created it not in vain, He formed it to be inhabited: I am the Lord; and there is none else. Isa. 45: 18.

The work of creation week was not wrought in vain. God's great plan to have the world inhabited by holy, righteous beings has been delayed but not defeated. The great opposition manifested by Satan to God's plan has revealed his selfish, deceptive spirit. The angels have been amazed as they have seen his cruel working; and they have marveled at the wonderful love manifested by their Creator, the Redeemer of man.

In our study of creation, we have wondered many times whether the misery and suffering in the world would ever cease. But the day of deliverance is almost here. Our Creator and Redeemer died, but not in vain. All that has been lost by sin

will be restored. "Behold, I make all things new." God's original purpose in creating the earth will be fulfilled, and this planet will become the eternal abode of the redeemed. "The righteous shall inherit the land, and dwell therein forever."

"In the Bible the inheritance of the saved is called a country. There the heavenly Shepherd leads His flock to fountains of living waters. The tree of life yields its fruit every month, and the leaves of the tree are for the service of the nations. There are ever-flowing streams, clear as crystal, and beside them waving trees cast their shadows upon the paths prepared for the ransomed of the Lord. There the wide-spreading plains swell into hills of beauty, and the mountains of God rear their lofty summits. On those peaceful plains, beside those living streams, God's people, so long pilgrims and wanderers, shall find a home."

The New Jerusalem will be the metropolis of the new earth. The city will be three hundred and seventy-five miles square, surrounded with walls of jasper supported by twelve foundations of precious stones. On each side will be three gates, each gate consisting of a single pearl. The gates are connected by long, gold-paved streets, which extend from one side of the city to the other. The foundations of the walls are garnished with all kinds of precious stones. This city God is preparing for all who are fitted to live in that beautiful country.

"In the city of God 'there shall be no night.' None will need or desire repose. There will be no weariness in doing the will of God and offering praise to His name. We shall ever feel the freshness of the morning, and shall ever be far from its close. 'And they need no candle, neither light of the sun; for the Lord God giveth them light.' The light of the sun will be superseded by a radiance which is not painfully dazzling, yet which immeasurably surpasses the brightness of our noontide. The glory of God and the Lamb floods the holy city with unfading light. The redeemed walk in the sunless glory of perpetual day."

The study of God's wonderful creation will be continued in the earth made new. There we shall have much greater opportunities for study, and much better teachers. "There every veil that darkens our vision shall be removed, and our eyes shall behold that world of beauty of which we now catch glimpses through the microscope, or when we look on the glories of the heavens now scanned afar through the telescope. When, the blight of sin removed, the whole earth shall appear in the beauty of the Lord our God, what a field will be open to our study! There the student of science may read the records of creation, and discern no reminders of the law of evil. He may listen to the music of nature's voices, and detect no note of wailing or undertone of sorrow."

In our study and observation, we shall not be confined to this world. "All the treasures of the universe will be open to the study of God's redeemed. Unfettered by mortality, they wing their tireless flight to worlds afar,— worlds that thrilled with sorrow at the spectacle of human woe, and rang with songs of gladness at the tidings of a ransomed soul. With unutterable delight the children of earth enter into the joy and the wisdom of unfallen beings. They share the treasures of knowledge and understanding gained through ages upon ages in contemplation of God's handiwork. With undimmed vision they gaze upon the glory of creation,— suns and stars and systems, all in their appointed order circling the throne of Deity. Upon all things, from the least to the greatest, the Creator's name is written, and in all are the riches of His power displayed."

We are still on the earth that God gave to our first parents. While it is marred by sin, yet there are in it many things that are lovely and beautiful. May these things encourage us to live so that we can have a home where all is beauty and joy and peace. Like all the faithful children of God in past ages, we are "strangers and pilgrims on the earth." We, too, desire "a better country, that is, an heavenly," and we are looking "for a city which hath foundations, whose builder and maker is God." Soon God's plan in creation and redemption will be finished, and a voice will be heard from heaven saying, "It is done." Then the

prayer Christ taught us to pray will be answered: "Thy kingdom come. Thy will be done in earth, as it is in heaven."

As we study these lessons on the wonderful works of God, let us do what we can to answer this prayer. And when it is finally answered, may we all be present to continue our study in the earth made new.

"As the new heavens and the new earth, which I will make, shall *remain before Me, saith the Lord,* so shall your seed and your name remain. And it shall come to pass, that from one new moon to another, and from one Sabbath to another, shall all flesh come to worship before Me, saith the Lord." Isa. 66: 22, 23.

A PHOTOGRAPH OF THE MOON

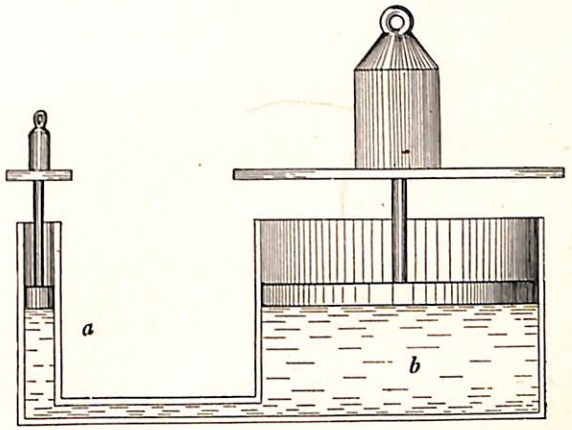
SUPPLEMENT

SUPPLEMENT

Why Objects Float or Sink

Objects that are lighter than air will float in the air, while objects that are heavier will fall to the ground. In like manner objects that are lighter than water will float on the water, and objects heavier than water will sink.

Water presses in every direction,— downward, upward, and outward. This is true of all liquids. The downward and outward pressure of water is everywhere seen, and the upward pressure is easily understood if one attempts to push an empty pail downward against the surface of water. If there are holes in the bottom of the pail, the force of the upward pressure fills it with water. A cork does not sink in water as does a piece of wood. This is because the downward pressure of the cork is less than the downward pressure of wood. A floating object will sink until the downward pressure of the object is balanced by the upward pressure of the water. When the downward pressure of the object is greater than the upward pressure of the fluid, the object will sink.



THE UPWARD PRESSURE OF WATER

a, Cylinder one inch in diameter
b, Cylinder ten inches in diameter

The larger the surface of water covered by an object resting upon the water, the greater the upward pressure will be; hence vessels made of substances heavier than water, may be so shaped that the upward pressure of the water will balance the downward pressure of the vessel, and the vessel will then float. This explains why iron may be used to build great ocean steamers, even though it is heavier than water.

In the illustration the two cylinders are connected by a pipe through which water may flow freely. If a weight of one pound is placed upon the cylinder that is one inch in diameter, a weight of 100 pounds placed upon the covering of the cylinder ten inches in diameter will exactly balance. Although the upward pressure per square inch is the same in cylinder *a* as in cylinder *b*, the total upward pressure in cylinder *b* is 100 times that of the upward pressure of the water in the small cylinder, because the area of pressure is 100 times greater. This is the way power is multiplied and used in lifting heavy drawbridges to allow ships to pass through.

Experiment

Place the following objects upon water, and note the results: cork, dry wood, green wood, beans, an egg, a piece of iron, a spoon.

Questions

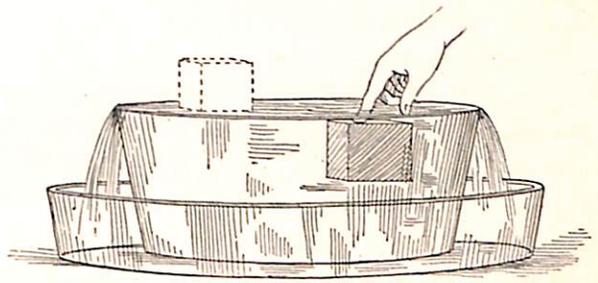
1. Why will an empty iron kettle float upon the surface of water when right side up, but sink when bottom side up?
2. How do you know water has downward and outward pressure?
3. Prove that water has upward pressure.
4. What will occur if the downward pressure of an object placed upon the surface of water overbalances the upward pressure of the water?
5. Would the upward pressure of a liquid heavier than water be greater or less than the upward pressure of water?
6. Into which will cork or a piece of wood sink farther when floating, into water or mercury? Why?
7. Explain why vessels made of iron will not sink.

Note Book Requirement

On page 25 answer the above questions.

Specific Gravity

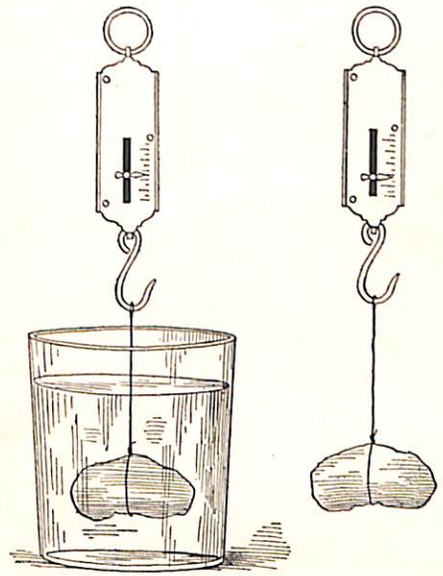
The power that attracts all objects to the earth is called *gravity*. Were it not for this power, objects would fall away from the earth just as easily as they fall toward it. This is a manifestation of the power of God, for by Him "all things consist," or hold together. Col. 1: 17.



HOW TO FIND THE SPECIFIC GRAVITY OF WOOD

"Gravity" is another name for weight. The gravity of an object is equal to the force with which it is attracted to the earth.

The weight of any substance as compared with the weight of water is called its *specific gravity*. This is determined by comparing the weight of any given substance to the weight of an equal volume of water. The ratio of the weight of any substance to the weight of an equal volume of water gives the specific gravity.

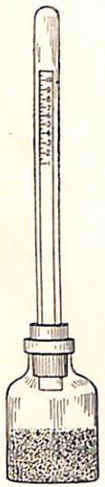


HOW TO FIND THE SPECIFIC GRAVITY OF IRON

To determine the specific gravity of wood, or of any substance that will float in water, first weigh the wood or other substance in the air. Place a pail in a large basin, and fill the pail just level full of water, not allowing any to run over into the basin. Now completely immerse the piece of wood in the water. This will cause the water to overflow, for the wood

will displace its own volume of water. Now weigh the water which ran over into the basin, and divide the weight of the wood in the air by the weight of the water displaced. This simple process will give the specific gravity of all objects lighter than water.

To determine the specific gravity of objects heavier than water, there is a still easier way. First weigh the object in the air. Then weigh it in the water. The loss of weight is the weight of the displaced water. Divide the weight in the air by the difference between the weight in the air and the weight in the water, and the result will show how many times heavier the object is than the water.



THE HYDROMETER

We may speak of the specific gravity of a liquid, as well as the specific gravity of a solid. The specific gravity of liquids may be measured by a simple little instrument known as a *hydrometer*. This specific gravity measurer consists of a small glass tube the upper part of which is marked with a scale for measuring. The lower part of the hydrometer is weighted with mercury or shot in order to keep the instrument in an upright position. The zero of the scale marks the depth to which the hydrometer sinks in pure water. When placed in a liquid heavier than water, it will not sink to the zero point. When placed in a liquid lighter than water, it will sink beyond the zero point. Special hydrometers are manufactured for different purposes. The addition of water or other liquid can be detected in milk by use of the hydrometer.

In the study of heat, we have learned that heat *expands*, and that cold *contracts*. In the case of water, we have an exception to the general law which reveals the wonderful care of the great Lawgiver for the creatures He has made.

Notice carefully, in the case of water, the exception to the rule. True, water always expands when heated, and it contracts

when cooled, until the temperature falls to between 39° and 40° F., and then it begins to expand, and at 32° F. it freezes, forming ice, which floats on the water. The lower the temperature, the more the ice expands.

Now if the water continued to contract, the ice would sink as it formed, and our rivers and lakes would freeze to the bottom, thus destroying all animal life in the water. Therefore here we see the Creator reversing one of His general laws, in order that the animals that inhabit the water may live in comfort during the cold winter season. "The Lord is good to all: and His tender mercies are over all His works."

The laws of nature are God's laws, and are simply His usual way of working. Even the law of gravity may be suspended if He so desires.

Specific Gravity of Certain Substances

Platinum	21.5	Tin	7.3	Lead	11.4
Gold	19.3	Copper	8.8	Iron	7.6
Ice	.9	Mercury	13.6	Cork	.24
Silver	10.4	Beech	.8	Zinc	7.1
Olive Oil	.92	Oak	.6	Alcohol	.81
Boiling Water	.95	Sea Water	1.03	Ordinary Stone	2.7
		Water from the Dead Sea	1.24		

Questions

1. Which of the substances named above will float in water?
2. Which will sink?
3. How many of the metals mentioned are heavy enough to sink in mercury?
4. Why can a fat man swim more easily than a lean man?
5. Why can stones be lifted more easily in water than on land?
6. Why is it so difficult to wade in deep water?
7. Why can one float more easily in ocean water than in fresh water?
8. Why does cream rise on milk?
9. Why does ice float?
10. Why did the ax of Elisha's pupil float on water, if iron is heavier than water? 2 Kings 6: 5, 6.

Note Book Requirement

Explain the illustrations found on pages 25 and 26.

The Properties of Matter

We have already learned that whether matter is visible or invisible, it occupies space and has weight. Now the greater part of this earth is solid matter; but heat, pressure, and cold are constantly changing matter from one condition to another. The greater part of the interior of the earth is a mass of rock. But we know that heat can melt the hardest rock, causing it to flow like water; and we know that water, air, cold, and pressure are constantly at work upon all matter that we see about us.

There are certain properties that belong to all matter. Such properties as are common to all its forms are known as *general properties.*

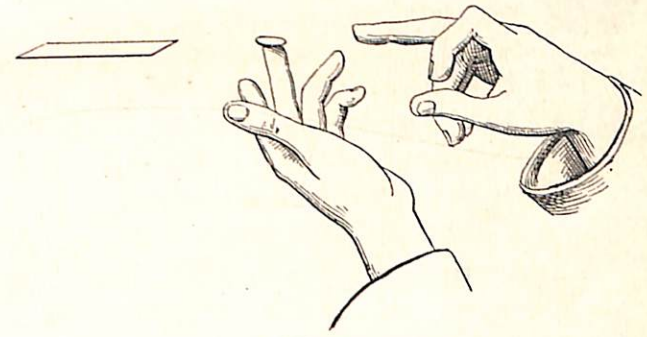
All matter is *divisible.* Break a stone into small pieces. As long as the parts can be seen by the naked eye, they are called *masses.* The smallest parts into which it can be divided and still retain its nature, are called *molecules.* The very, very small particles of different nature which compose the molecule are called *atoms.* We shall learn more about this later.

All matter is *impenetrable.* That is, two masses, molecules, or atoms can not occupy the same space at the same time. Two books or balls can not be in the same place at the same time; a glass can not be filled with water and air at the same time; a stone will displace its own volume when dropped into a basin full of water.

All matter is *indestructible.* It can not be destroyed by man. The disappearing ice and snow are not destroyed, but only changed into water and vapor. The burning stick of wood changes into smoke, gas, steam, and ashes.

The tendency of matter is to remain in a fixed position. This property of matter is called *inertia.* If a coin is placed upon a cardboard and balanced upon the finger tip, it is possible to force the cardboard suddenly from underneath the coin without disturbing the position of the coin upon the finger. This illustrates the property of inertia. That property is also illustrated by the tendency to fall if standing in a wagon, or to fall over the back of the seat if sitting in it, when the team starts suddenly to run. Inertia is a very necessary characteristic, or tendency, of matter; and yet matter must sometimes be moved. Watch the engineer start his locomotive. Notice how the wheels turn and the fire flies when he tries to start it quickly. It almost refuses to go.

Properties not belonging to all matter are called *specific* properties. Gold, lead, and iron are *malleable,* which means that they can be pounded out into thin sheets. Glass and rock are *brittle,* which means they will break into small pieces when they are pounded. Iron and lead are not only malleable, but also *ductile;* that is, they can be drawn out into wires. Rubber is *elastic,* because it may be stretched, and will return to its original form. Other specific properties of matter are *softness* and *hardness.*



INERTIA

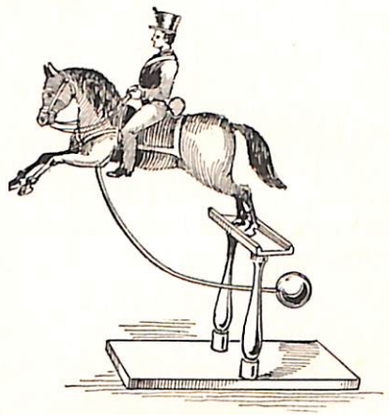
As we study the general and specific properties of matter, we must remember that they were imparted to it by the Creator, who made all the different materials with just such characteristics as fit them best to serve the purposes for which they were made. He has given each one of us those qualities,— that personality,— which will best fit us to fill the place we were made to occupy. Not all have the same personality; but all, like the different kinds of matter, have not only a general, but a specific influence, to exert for good to all.

Every particle of matter in any mass is pulled toward the earth by the force of gravitation. There is a point in every mass upon which, if supported, the body will balance. This point is called its *center of gravity*.

WHY DOES IT NOT LIE DOWN?

To find the center of gravity of any mass, suspend it successively in two positions, and pass an imaginary line through it vertically in each position. The point at which the two lines cross is the center of gravity.

The *stability* of matter depends upon the ease or difficulty with which a body supported at its base may be overturned. Any mass supported in such a way that its center of gravity must be raised instead of lowered in order to change its position has greater stability; that is, it is less easily overturned. If you imagine a line drawn from the center of gravity of a body toward the center of the earth, and that line fall within the base, or support, of the body, then it will stand; but if it come outside the base, the body will fall. The lower the center of gravity, the more stable the object. Hence it is best to sit down in the boat or wagon when there is danger of upsetting. Ballast — a heavy material — is placed low down in the hold of a vessel to make it steady in the water.



PRANCING TOY HORSE BALANCED BY BALL

Pith toys fashioned in various ways are very interesting, and illustrate the principle of the center of gravity. Pith is a very light substance. If to one end of a cylinder of this material a hemisphere of lead be fastened, the toy will not lie in a horizontal position, but will rise and assume a vertical position. This is because the center of gravity is low, or very close to one end of the toy.

The prancing toy horse to which is fastened a lead ball by a stiff wire, does not fall. Why? — Because the center of gravity is not over the base of support, but under it.

Experiment

Fasten a string to a potato by means of a tack or a pin, as seen in the illustration on page 31 of Note Book. When the potato is at rest, the center of gravity must be somewhere in the vertical line continued downward from the string, through the potato. Thrust a stiff wire through the potato so as to represent this line. Now suspend the potato from some other point, and again thrust the wire downward through it. This line also will pass through the center of gravity; and since the center of gravity lies in both of these lines, it must be at the point at which they cross each other. If the potato is now cut through along the lines made by the wire, we shall have four pieces of potato, and where the four inner corners come together is the center of gravity.

ADJUSTING GRAVITY TO KEEP FROM FALLING

Questions

1. Name and define the general properties of matter. Specific properties. Give examples of each.
2. Why is matter endowed with specific properties? What lesson can we draw from this?
3. What is gravity? What is the law of gravitation? By whom was it discovered?
4. What is meant by "the center of gravity"? How can it be determined?

5. Upon what does the stability of matter depend? The stability of character? Gen. 49: 3, 4; James 1: 5-8.

Note Book Requirement

Write out an explanation of the illustrations on pages 30 and 31, and the first illustration on page 32.

Matter and Motion

The Spirit of God moved upon the face of the waters. Gen. 1: 2.

A scientist was once asked for a definition of *motion.* Without saying a word, he rose from his chair, and walked back and forth before his class, as much as to say, "You see it, but I can not tell you what it is."

It is true that we can not tell very much about how motion is produced, but we know that the Creator is the author of all motion. The apostle Paul says, "In Him we live, and *move,* and have our being." On the first day of the creation week "the Spirit of God moved upon the face of the waters." God's Spirit was the great *moving* agency that started movements which brought order out of confusion, forming a world of order and beauty; and this same Spirit is now guiding and controlling in the operations of nature.

The Holy Spirit not only moved in the work of creation, but "holy men of God spake as they were moved by the Holy Ghost," and as a result we have the Bible.

In this lesson we wish to study some of the motions of the bodies that are common about us. Motion, as we observe it, is *the act of changing places,* as opposed to *rest.*

When a body passes over equal spaces in equal successive portions of time, its motion is called *uniform.* The motion of a pendulum is uniform.

When the space passed over in equal times continually increases, the motion is called *accelerated;* and when such spaces

decrease, it is called *retarded.* A stone thrown into the air is retarded while ascending, and accelerated while descending.

The swiftness of motion is called *velocity,* and is measured by the space passed over in a given time, as we say the train goes forty miles an hour.

The force or strength of motion is called its *momentum,* and is found by multiplying the quantity, or weight, of the body by its velocity. A ball weighing ten pounds, and having a velocity of one thousand feet a second, has a momentum of 10,000 units of energy. A body weighing one thousand pounds, moving with a velocity of ten feet a second, would have the same momentum. In other words, small bodies moving rapidly have the same momentum as large bodies moving slowly.

VIOLATION OF THE FIRST LAW OF MOTION

Now we will tell you something about motion, that may not at first seem to be true; but think it over carefully before making your decision. It is a scientific fact: 1. That a body may be in motion and yet not move. 2. That a body may be at rest and yet move. Now for the proof: Did you ever see a squirrel run on a wheel in its cage, just as fast as it could go, and not go anywhere, and then suddenly stop running, and move around with the wheel? Have you seen horses walking in a treadmill and yet not going anywhere? They walk for hours and yet do not go out of the yard. If they had gone through the same motions on the ground, hitched to a wagon, they might have taken you to the next town and back.

One more illustration: If a brakeman should go aboard the first car of a freight train one mile in length, whose engine was then at the station, and should run on the top of the cars, in

an opposite direction and at the same rate of speed that the train was moving,— ten miles an hour,— how far would he have traveled when the last car would pass the station? How far would he have ridden on the train? How far would he be from the station?

From this problem, we see that we have motion relative to the earth, and motion relative to the objects moving upon the earth. The brakeman, relative to the earth, was not moving forward at all; but relative to the train, he moved forward its whole length, one mile. If he had stood still, he would, relative to the earth, have moved forward one mile; but relative to the train, he would have been at rest. In the first instance, the brakeman's motion with reference to the earth is called *relative,* but his motion with reference to the train is called *absolute;* for relative to the earth, he was at rest, but as related to the train, he was absolutely in motion. In the second instance, his motion would have been *relative* compared to the earth, and absolute when compared to the train.

We have, then, five kinds of motion: 1. uniform; 2. accelerated; 3. retarded; 4. relative; 5. absolute. The real truth is that we know of nothing that is absolutely at rest. The earth is in rapid motion around the sun, and the sun itself is moving rapidly around some central body, and so on and on until we come to the great, grand center,— God's throne,— about which all things move in perfect harmony and order.

About two centuries ago a young man gave very diligent study to this subject, and discovered three laws that have since been called "Newton's laws of motion." Sir Isaac Newton was a great scientist, and his discoveries have been a great blessing to mankind. He was not only a diligent student of nature, but he was also a diligent student of the Bible. His study of science did not lead him away from the God of science and the Bible, but the study of both of these led him to live a devoted Christian life. The following is inscribed on his monument in Westminster

Abbey, London, where he was buried March 28, 1727: "An unwearied, keen-minded, and faithful interpreter of nature, history, and the Holy Scriptures, he asserted the majesty of God, and exhibited in his conduct the simplicity of the gospel. Let mortals rejoice that there has existed such and so great a benefactor of all mankind."

These are the three laws that he discovered:—

First Law.— Every body continues in its state of *rest,* or of uniform *motion* in a straight line, unless acted upon by some external force.

This law means that a body at rest can not put itself in motion, and that a body in motion can not stop itself. Bodies at *rest* are set in motion by horse power, water power, wind power, electricity, etc.; and bodies in motion are stopped by friction, gravity, or some resisting body. If you start a ball rolling, it will soon stop. If you push an object suddenly, it will slide a short distance and stop. In both these instances, the rougher the surface, the sooner the object will stop. This rubbing of the surfaces is called *friction.*

SHOWING FIRST LAW OF MOTION

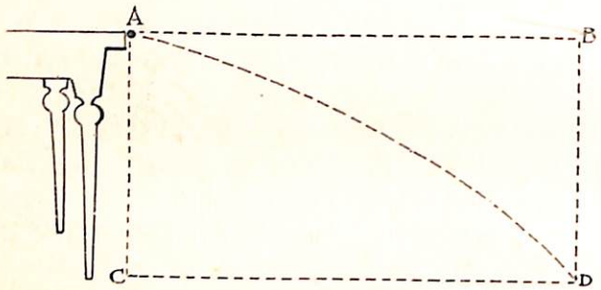
Throw a ball horizontally, and it will soon stop. Why? There are two opposing or resisting causes. One is the friction produced by the resistance of the air, and the other is the downward pull of the force of gravity.

Because this first law of motion is not heeded, many persons are injured, and sometimes very seriously. Remember that according to this law, a body in motion tends to *keep* in motion, as well as a body at rest to *remain* at rest. When riding on a train or street car, the body is in motion with the moving train or car. When one alights, and attempts to stop his motion instantly, it is very difficult to do so without a serious jar to the body. Some thoughtlessly step to the ground, sometimes facing backward, and in an instant they are thrown flat to the ground. One should always wait till the car or train stops before alighting. If necessary to step from a moving train or car, step to

the ground face forward, and take a few steps in the direction you are going.

Second Law.— Change of motion is proportional to the force impressed, and in the direction of the line in which that force acts.

This second law is illustrated by the throwing of the ball mentioned above. If it were not for the force of gravity, it would go in a straight line until stopped by the resisting air; but instead, the path of the ball is a curved line. If gravity alone were acting, the path would be a vertical line. When the hunter fires his gun, he must take into account the downward force of gravity. If the object is far away, he must aim a little above it, or the ball will pass below the object.



ILLUSTRATING SECOND LAW OF MOTION

Third Law.— Action and reaction are equal and in opposite directions.

This third law is not quite so easy to understand, but a few illustrations will make it plain. Push against the ground or wall with a stick, and you are pushed equally as hard in the opposite direction. If you quickly push a large movable object in one direction, you will be pushed in the opposite direction with the same force you exerted.

This is what happens when a man fires a heavily loaded gun. It may almost cause him to fall over backward, and he will say the gun "kicks." A cannon fired from the side of a boat will cause it to tip in the opposite direction. If fired from the bow of a moving boat, it will retard its motion; if from the stern of the boat, it will increase its speed. This is a rather hard

lesson for those just beginning the study of elementary physics, and therefore we will have a few experiments that will be interesting, and help you to understand better the laws of motion.

Experiments and Problems in Motion

First Law of Motion — Inertia

Experiments

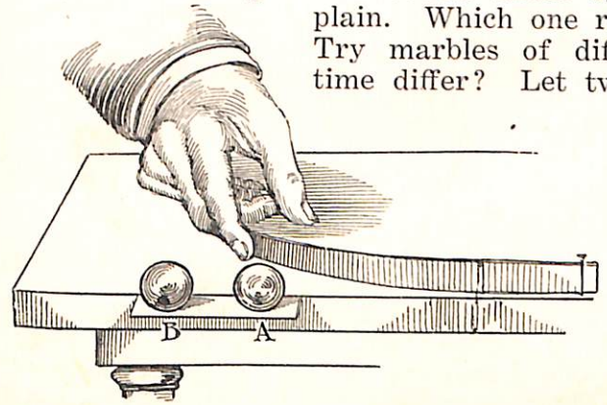
1. Balance a coin on a card on the end of your forefinger, and snap the card out from under the coin, leaving the coin balanced on the finger. If this is too difficult, place the coin and the card on the corner of a table and knock the card out horizontally.

2. Suspend a ball by a small string, and tie another piece to the under side of the ball. Pull slowly on the bottom string. Which string breaks? Why? Pull very suddenly on the lower string, and explain what happens.

Second Law of Motion — Change of Direction

Experiments

1. Snap a marble off the edge of a table, and drop another marble from the same place at the same instant. Draw a diagram showing the direction taken by each marble, and explain. Which one reaches the ground first? Try marbles of different sizes. Does the time differ? Let two boys try this experiment from the top of a building, one throwing a ball horizontally, and the other dropping another at the same instant. Compare direction and time with the marble experiment.



2. Roll a ball against the wall. What occurs? Roll a ball

against another ball of equal size. Roll it against a larger ball. What occurs in each instance? Why? Notice what occurs when two cars come together in a freight yard.

Third Law of Motion — Reflected Motion

Experiment

Throw a ball perpendicularly to the floor. What direction does the ball rebound? Now throw it in some other direction against the floor. In what direction does it rebound? Why does it rebound? Why does a rubber ball bound higher or farther than other balls?

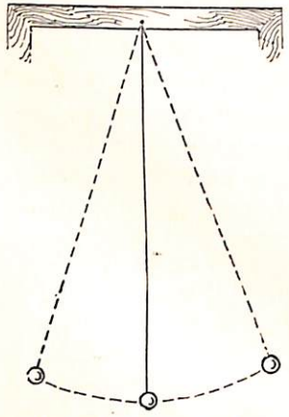
Draw two lines to represent the directions taken by perpendicular and slanting balls when thrown to the floor, and two lines to show the direction of their rebound, called *reflected* motion. Compare the size of the two angles made by the perpendicular line, and the two *oblique,* or slanting lines. Which is the angle of *incidence* and which the angle of *reflection?* (See lesson 6, Book 2, "Reflection of Light.")

Motion of Composite Forces.— Motion resulting from two or more forces acting on a body at the same time can be illustrated as follows:—

Experiments

1. Let two boys of equal strength push or pull each other or some object in opposite directions. What is the result?

2. Let these two boys push or pull an object at right angles, using equal strength. What is the direction taken by the moving object? Draw a diagram showing the direction of the forces and the *resultant* motion.



MOTION OF PENDULUM

Motion of the Pendulum

Experiment

Suspend three balls of equal size by cords six, twelve, and eighteen inches in length. These we will call pendulums. We want them to swing. Will you need to do anything to make them swing? What? Cause them to swing, or *oscillate.* Will you need to do anything to stop their swinging? What law of motion is here illustrated in the pendulum? Of what use is the spring in a clock? Do the three pendulums swing through equal distances (*arcs*)? Do they all pass through their arcs in equal times? Does each pass through its own arc in equal times? What does the length of the pendulum have to do with the size of the arc, and the time of the swing, or vibration? How many times does the six-inch pendulum vibrate to one vibration of the twelve-inch pendulum? Of the eighteen-inch pendulum?

Motion of Freely Falling Bodies

Experiment

In this experiment, use the one of the three pendulums best suited for a timekeeper. Start the pendulum to oscillating. Now let one boy throw a ball straight up into the air, and another boy count the vibrations made by the pendulum till the ball strikes the ground. Count the vibrations for the ascending ball. For the descending ball. How do they compare?

Newton found that gravity causes an object to fall toward the earth about sixteen feet the first second, and that this impulse would bring it to the ground with a uniform velocity (thirty-two feet a second), even if the force of gravity were taken away. But this force continues to act during the next second, and during each succeeding second of time, so that the motion is *uniformly accelerated,* or increased. It has been found that a body falls forty-eight feet during the *second* second, or sixty-four feet in two seconds. It then appears that sixteen feet of the forty-eight feet of the *second* second is due to gravity, and the remaining thirty-two feet is due to the velocity which the ball had acquired while falling sixteen feet during the first second.

The velocity increases thirty-two feet each second, and therefore is called *uniformly accelerated* velocity. The velocity at the end of any given second can be found by multiplying the number of the second by thirty-two. Thus the velocity at the end of the sixth second is $6 \times 32 = 192$; that is, 192 feet a second.

The number of feet passed over during any given second is found by adding the number of the given second to the one

before, and multiplying the sum by sixteen. Thus the number of feet covered during *the sixth* second is $(6+5) \times 16$ feet $= 176$.

The entire distance passed over during any given number of seconds can be determined by *squaring* (multiplying by itself) the number of seconds, and multiplying the product by sixteen. The entire space passed over during six seconds is $6 \times 6 \times 16$ feet $= 576$ feet. Now the velocity and the space passed over increase as the time increases. You may not now understand the mathematical processes and principles involved in working these problems, but later you will study them again, and study for yourself what Sir Isaac Newton studied when he was a young man. You remember he worked sixteen years — just the number of feet he found a body falls the first second — before he found the way to work this very problem that we are studying, of freely falling bodies. Hence you must not become weary or discouraged in working your problems. The same God who helped Newton, is the great author of all mathematics, and He will help you.

How high is a building from the top of which a stone falls to the ground in three seconds? What is the velocity of the stone at the end of the third second? What space does it pass through during the third second?

Measure the height of your house and of the school building in this way.

Questions

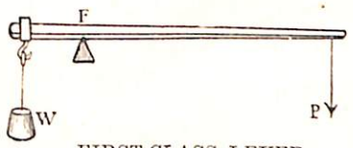
1. Define matter. Define motion.
2. Who is the author of matter? Of motion? What is there mysterious about motion?
3. When is motion first referred to in the Bible? What agency produced it? What was the result?
4. Has this moving agency operated since creation? What was the result? 2 Peter 1:21.
5. What causes the movements in creation to-day? Acts 17:28.
6. Name and illustrate the five kinds of motion.
7. Is there anything absolutely at rest?

8. Who discovered the three laws of motion? What other great law did he discover?
9. State these three laws of motion, and illustrate each.
10. What is inscribed on Sir Isaac Newton's monument? Does this teach that the study of the Bible and nature should go hand in hand?

Lifting Machines

I wisdom dwell with prudence, and find out knowledge of witty inventions. Prov. 8:12.

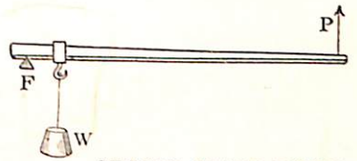
All have observed that masses of matter fall toward the earth if lifted above it. The power that pulls toward the earth is called *gravity*. But what is it in reality?



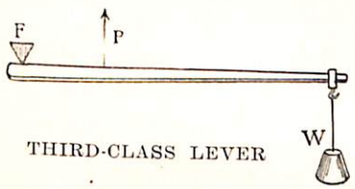
FIRST-CLASS LEVER

This power is everywhere present, and the measure of the pull is equal to the weight of the object in pounds. This is determined by the use of the various kinds of scales.

In lifting objects, man has to work against this power, and many times it pulls with so strong a force that he can not possibly overcome it without some aid.



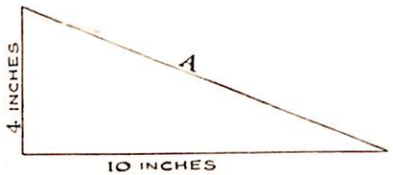
SECOND-CLASS LEVER



THIRD-CLASS LEVER

To enable him to multiply his lifting power, man has taken advantage of certain mechanical powers, and has invented simple machines. There are three mechanical powers: 1. the lever; 2. the pulley; 3. the inclined plane. Nearly every one is familiar with some kind of machinery, and in this lesson a few of the most simple machines are studied, with the mechanical powers used.

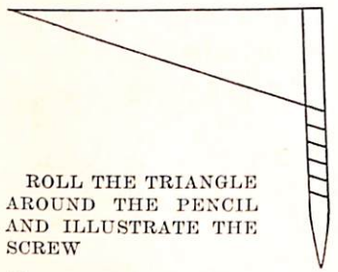
The lever, consisting of a straight bar of wood or iron, may be used in lifting stones and stumps out of the ground. Any inflexible bar supported by a fulcrum about which it moves freely, is a lever. By bending the bar of iron or steel near one end, you can form a fulcrum in the first-class lever. Scissors and forceps are double levers of the first class. There are three classes of these levers.



TO ILLUSTRATE THE SCREW

The *first class* is a lever with the power applied at one end, the weight at the other, with the *fulcrum* between, usually nearer the end which supports the weight.

The *second class* is a lever which has the object lifted between the fulcrum at one end and the power at the other. Nut-crackers and lemon squeezers are levers of this class. The bones in the foot form this kind of lever in raising the body when standing on tiptoes. The toes form the fulcrum, and the power is applied by a muscle attached to the heel, while the body is lifted by the bones near the ankle. The wheelbarrow is a second-class lever with a rolling fulcrum. So also is the oar of a boat, the water being the fulcrum, the person rowing being the power, and the boat the load moved forward.


ROLL THE TRIANGLE AROUND THE PENCIL AND ILLUSTRATE THE SCREW

The *third class* is a lever which has the power applied between the weight at one end and the fulcrum at the other.

The forearm of the human body is a wonderful example of this class of lever. The weight is in the hand, the fulcrum is at the elbow, and the power is applied between the two by the biceps muscle.

A man can lift many times as great a weight with a lever as without it, but it takes a longer time to lift the load.

The *pulley* is another simple machine. It is often used in lifting water from a well with a bucket. With this device one pulls down instead of pulling up. This is much easier, as the one pulling can add his weight to the downward pull of the rope. Pulleys are used in lifting stones, steel, and timber in erecting buildings; and they are used also in unloading hay. The more pulleys used, the more easily the load is lifted.

SCREW

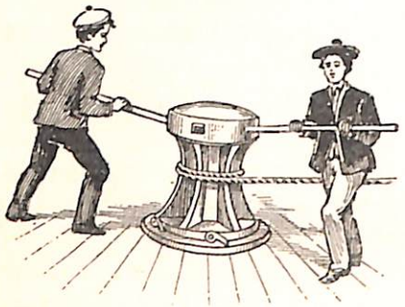
The inclined plane, which may consist of only a board or a plank, is of great use in loading barrels on a wagon. Longer time is required, but the work is more easily done.

The jackscrew is a continuous inclined plane used in lifting buildings. This can be illustrated by winding a right-angled triangular piece of paper around a pencil. The inclined plane is shown by the continuous spiral winding edge of the paper. This is the same as the threads on the screw. The jackscrew is a very powerful and yet simple machine. The iron bar used in turning the jackscrew is a lever. In this machine, we have the inclined plane and the lever combined. A letter press works on the same principle as the jackscrew.

WEDGE

A wedge is a simple machine consisting of two inclined planes placed back to back. It is of much use in splitting logs and stone, in raising heavy weights a short distance, and in launching ships. The method of applying the power makes it difficult to give any fixed law for the wedge; but, as in the case of the inclined plane, the power times the power distance is equal to the weight or resistance times the weight or resistance distance. Suppose a wedge is two inches in thickness and eight inches in length. If the pressure of a blow upon the wedge is 100 pounds, the average pressure exerted by the wedge in separating the fibers of wood is 400 pounds, P × Pl (length of wedge) = W × Wh (height, thickness, or base of wedge), 100 × 8 = W × 2. 400 = W.

The wheel and axle, or windlass, is another very effective machine for lifting. It is a lever, but acts continuously in a circle, the fulcrum being a part of the machine. It is often used in lifting water from deep wells. The capstan is a perpendicular windlass used to move buildings. It is also used on large vessels, for raising anchors. By placing capstan bars in the holes at its head, many men can work at once.



THE CAPSTAN

Examine the simple but powerful machines that man has invented to enable him to overcome the ever-present force, gravity. Necessity is surely the mother of invention. While this power many times seems to work against man, he could not do without it, for everything would fall off the earth — yes, and so would man also, were it not for this sometimes helping and sometimes hindering but very necessary power.

The machines which have been invented multiply a man's power, so that one man can do the work of many.

Questions

1. What force in nature does man have to work against continually? Is it to his advantage or disadvantage to have this force to contend with?
2. What has man done to aid him in overcoming this force when necessity requires? Name the three mechanical powers.
3. Name and describe the three classes of levers.
4. Name the simple machines mentioned in this lesson that depend on the principle of the lever.
5. Describe the inclined plane, and indicate its usefulness. Compare with the jackscrew and the letter press.
6. Describe the pulley, and tell in what way it is of service.
7. Describe the wheel and axle, or windlass, and state its use. What is the capstan?

Experiments and Problems with Lifting Machines

The Lever

Experiments

1. The seesaw game will serve to illustrate the principle of the lever. Secure a plank twelve feet long, with the number of feet marked off on it. If the plank rests on a support (fulcrum) at its middle point, what is the condition of the plank? Now place two children of the same weight on the two ends. What occurs? Place on the two ends two children of unequal weight. What takes place? What must now be done to keep the plank balanced? Can you so adjust the plank that the lighter child can lift the heavier one? How? Can you so adjust it that one child weighing fifty pounds can lift another weighing one hundred pounds? Two children weighing one hundred pounds each? How many feet is each end of the plank from the support in each case?

2. Take a two-foot or three-foot ruler, and make a hole at the middle point, then place a nail in this opening, fastening it to some support so it will exactly balance. The ruler should be fastened in such a way as to be free to move up and down. Make other holes every three inches on both sides of the middle hole in a two-foot ruler, and every six inches in a three-foot ruler. It would be well to nail the rulers to strips of wood of the same size, except thicker, or nail two rulers together, to give strength for the weights to be used.

Now provide twelve equal iron weights that can be hooked or tied to the ruler wherever desired. Balance the ruler with a weight at each end. Does the weight multiplied by the distance on one side of the fulcrum equal the weight multiplied by the distance on the other side of the fulcrum? Now balance the ruler (lever) in each hole, adjusting the weights at each end so as to secure exact balance. Does the weight multiplied by the distance on one side in each case equal the weight multiplied by the distance on the other side? It should. This is the principle on which the lever acts. A small weight with a long weight arm will balance or lift a large weight with a short weight arm. The distance from the weight to the fulcrum is called the *weight arm.* In the case of the lever, the arm lifting the weight is the weight arm, while the opposite arm, where the power is applied, is called the *power arm.* Then the power (P) multiplied by

the power arm (Pa) is equal to the weight (W) multiplied by the weight arm (Wa); or, P X Pa = W X Wa.

Now you can work a few lever problems:—

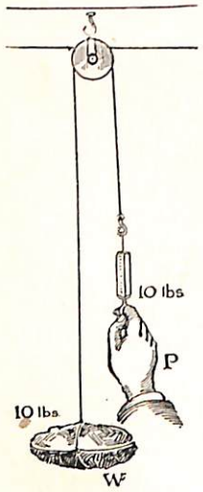
1. How heavy a stone can a man lift with a lever ten feet long, if he applies fifty pounds eight feet from the fulcrum?

2. A man desires to lift a weight of four hundred pounds with a lever ten feet long, and the fulcrum placed two feet from the weight. How much power must be applied by the man at the opposite end of the lever?

3. A man has a lever ten feet long, and applies fifty pounds of power to lift a barrel weighing two hundred pounds. Where is the fulcrum placed? How long is the power arm? The weight arm? P X Pd = W X Wd, or the power multiplied by the power distance equals the weight multiplied by the weight distance.

The Pulley

The advantage of the pulley is in the change of direction. While a man is pulling down, he lifts the weight. Several men can join in pulling, and lift a very heavy weight. The weight of their bodies aids very much. Horses can not pull down, but horizontally. Hence by the use of a pulley, a team can raise vertically a very heavy weight.



DOWN PULL THE ONLY ADVANTAGE IN LIFTING

Experiments

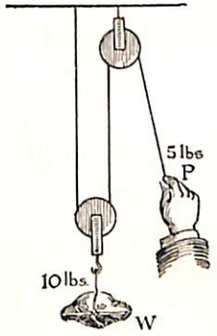
1. Procure six separate pulleys, and one block containing three pulleys. Fasten a single pulley to the ceiling or some support, and over this run a cord fastened to a ten-pound weight. Tie at the other end of the cord a spring balance, and lift the weight. How much power is required to lift the weight? Of what advantage was the pulley in this experiment?

2. Fasten the pulley directly to the weight, tying one end of the cord to a hook or nail on the wall, and the spring balance to the other end. Now lift the same weight. How much power does the spring balance show was exerted to lift the ten pounds? What part did the hook act?

To change the direction of the power, fasten a pulley on a hook to the ceiling or some support. This is called a *fixed pulley*, and has no advantage but the change of direction. The other pulley is called a *movable pulley*, because it moves upward with the weight. Notice whether the weight and the power move through equal distances. It will be found that the power moves twice the distance the weight moves, but only half the power is required to lift the weight, that was necessary with a fixed pulley. The same rule, or *formula*, is used for working the problems of the pulley as for those of the lever. P X Pd = W X Wd, or the weight multiplied by the weight distance equals the power multiplied by the power distance.

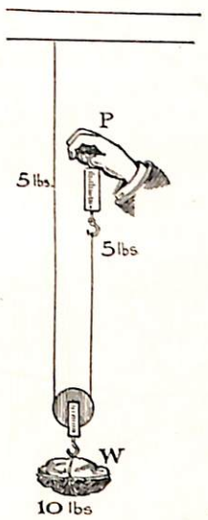
3. Add another movable pulley, and note the power required to lift the weight of ten pounds. With one fixed pulley ten pounds of power is required to lift ten pounds of weight, the only advantage being the change of direction.

With one movable pulley we double the lifting power, or lift a weight of ten pounds with five pounds of power.



EASIER TO LIFT, AND POWER WORKS IN RIGHT DIRECTION

With two movable pulleys we *quadruple* the lifting power, or lift ten pounds of weight with two and one half pounds of power. This is not exactly true, but it would be were there no friction. Let us work a few problems:—



EASIER TO LIFT, BUT POWER WORKS IN WRONG DIRECTION

1. With one fixed pulley, how much power is required to lift 100 pounds? With one movable pulley? With two movable pulleys?

2. With a fixed pulley, how many pounds of weight will ten pounds of power balance? With one movable pulley? Two movable pulleys?

3. With one movable pulley, the five-pound power distance is ten feet; what was the weight lifted, and through what weight distance? With two movable pulleys, what would be the result?

The Inclined Plane

The same principle applies to the inclined plane. The power multiplied by the length of the inclined plane is equal to the

weight multiplied by its height. P X Pl = W X Wh. The power acts through a greater distance, requiring more time, but a much greater weight can be lifted.

Experiment

Take a board twelve feet long, and place one end on the floor and the other end on a box three feet high. How much force would be required to pull a cart weighing twenty pounds up this inclined plane? Use the spring balance in pulling the cart.

Problems

1. A farmer wishes to load a barrel of apples weighing two hundred pounds into his wagon, which is three feet from the ground; and for this purpose he uses a plank twelve feet long. How hard must he push to roll the barrel up the plank?
2. An inclined plane is ten feet long and two feet high. How heavy a barrel can be pushed up this inclined plane with a pressure of fifty pounds?
3. A man rolls a barrel weighing four hundred pounds up an inclined plane with a pressure of one hundred pounds. How do the length and height of the inclined plane compare?

Three Great Forces

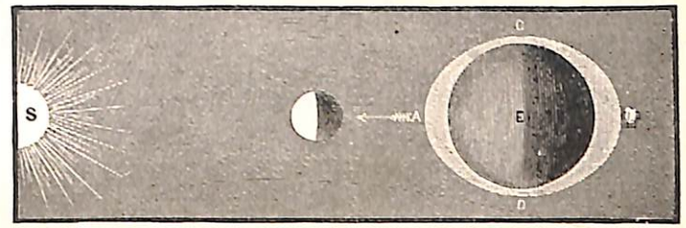
God hath spoken once; twice have I heard this; that power belongeth unto God. Ps. 62: 11.

There are three great powers, or forces, in nature which are very widely distributed throughout the earth, and which man has learned to use greatly to his own advantage.

Of two of these forces, gravitation and magnetism, you already have some knowledge; but the third force, electricity, will occupy our attention in this lesson. Let us, however, again refer to gravitation and magnetism, for there is still much to learn of them.

Gravitation is at work everywhere, and man does not need to prompt it to service. This force is a manifestation of the

power of the Creator to hold the earth in place, and keep objects on the earth. We recognize it when we have a hill to climb, or a heavy object to lift; and at such times we might wish it would suspend operations till we reach the top of the hill, or lift our heavy load. But fortunately it is not ours to control. If this power should cease to act for a moment, objects on the earth would not only fly off into space, and the earth get out of its path, but all the worlds would suffer a great shock. It is far better for us to lift against this force when necessary, than have all the worlds suffer to make things more convenient for us.



SPRING TIDES

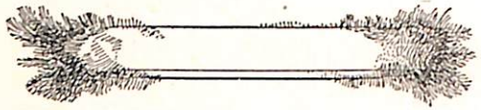
Gravitation, acting through the sun and moon, exercises a drawing force upon the earth; as magnetism, acting through the magnet, exercises a drawing power upon a piece of iron or steel. Of course this pull on the earth does not affect its solid portion; but it does affect the great oceans, which cover about three fourths of the earth's surface. It causes two great, swelling waves, many hundreds of miles broad, to pass around the earth, following the moon. When these swells reach the shore, water rises, forming what are called *tides*.

NEAP TIDES

Along the broad, open shores, the water rises about two feet only; but in the bays, it rises much higher, because of the nar-

row space near the head of the bay. In the Bay of Fundy, the tide rises to a height of forty or fifty feet.

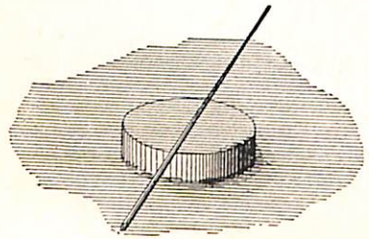
The height of the tide varies; for sometimes the sun and the moon pull together, making a much stronger lift than when they act separately. The sun and the moon are nearly in a straight line at the time of full moon and new moon; and then the highest tides come, called the *spring* tides. The tides that occur at the quarters of the moon are called *neap* tides.



STRAIGHT MAGNET COLLECTING IRON FILINGS

The tides are of great value to shipping, as many harbors can be entered, and rivers navigated, only at the time of the tides. A time schedule of their rise and fall is kept in seaport towns, for the benefit of navigators.

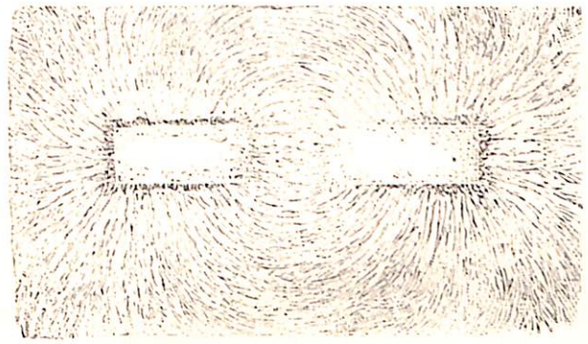
Magnetism, the second great force, does not usually manifest itself without the aid of man. This force is found in magnetite, or loadstone, as it is commonly called. The magnets are artificially made by magnetism transferred to the magnetic bar from another magnet or from loadstone. Magnets are more commonly made by passing a current of electricity through wire wound around a bar of iron or steel. Magnetism was quite fully presented in the second book of this series; therefore we will now study the third great force, electricity, which in many ways is quite similar to magnetism.



FLOATING COMPASS

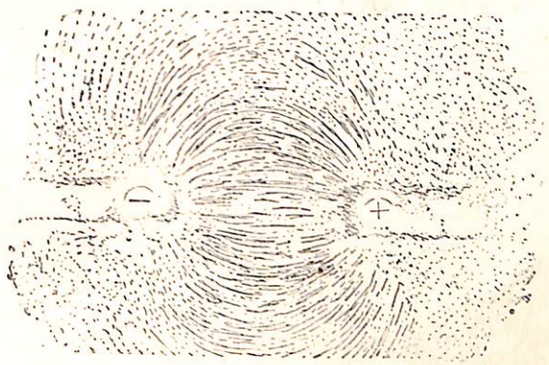
Both electricity and magnetism are in a quiet state until they are awakened, or, as the scientist says, *generated.* A machine called the *dynamo* is used for generating electricity. You should visit an electric light plant, and learn how electric light is furnished for towns and cities.

Benjamin Franklin, by flying a kite during a storm, proved electricity to be the agency that produces lightning. He succeeded in conducting electricity from the clouds by means of a hempen string attached to his kite. He found, among other things, that sparks could be drawn from a key tied to the string, on presenting the knuckle, and that a Leyden jar could be charged with electricity thus obtained. This discovery led to the invention of lightning rods to save buildings from destruction by lightning. That device is not much used now, as the lightning many times strikes the building if the rods are not properly grounded.



LINES OF MAGNETIC FORCE

Lightning is an electric spark passing from cloud to cloud, or between clouds and the earth. Thunder is the noise caused by the spark, and its rolling sound is made by the echoes among the clouds. In Job 37: 1-5, read a description of a thunderstorm. The Creator designs that these wonderful exhibitions of His power shall cause man to reverence and obey Him.

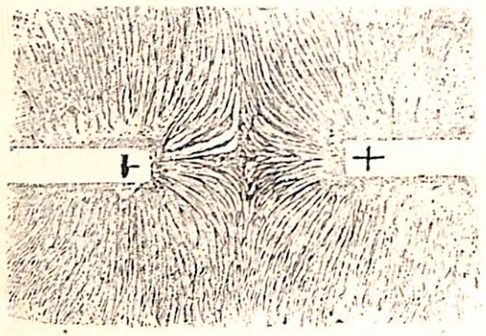


LINES OF MAGNETIC FORCE WITH UNLIKE POLES

Experiments

1. Place a darning needle two or three times on a piece of cork, and notice the position taken when the needle comes to rest. Now draw the needle several times across one pole of a

magnet, and place the needle again on the cork several times. Compare the positions of the magnetized needle with those before it was magnetized. Present each of the poles of the magnet to the needle, and explain the movements of the needle. What position does the needle always take when not influenced by the magnet?



LINES OF MAGNETIC FORCE WITH LIKE POLES

2. Place a sheet of paper over a straight magnet, and while tapping the paper lightly, sprinkle carefully some iron filings over the magnet, and observe lines of force as indicated by the arrangement of the filings. Notice the lines of force when the same operation is repeated with like poles and opposite poles placed together. Try the same experiment with a horseshoe magnet.

Questions

1. Name the great forces in nature of which this lesson treats.
2. Of what value is gravitation? How is it a hindrance? Can we get along without it?
3. What are tides? By what are they caused?
4. What inventions have been made to overcome the force of gravity?
5. Describe a magnet. How are magnets made?
6. How does magnetism act? What is the law of its action? What valuable instrument has been invented, based on this law?
7. How is electricity generated? In what ways are electricity and magnetism alike?
8. What did Benjamin Franklin discover while flying his kite during a thunderstorm? What invention followed? Was it of value?
9. How is lightning produced? Thunder? How should we be affected by these manifestations of God's power?
10. To whom does all power belong? Rom. 13: 1.

The Habits of Electricity

And the living creatures ran and returned as the appearance of a flash of lightning. Eze. 1: 14.

We can not create electricity; but we can *generate* it. By this I mean, collect or concentrate it at some point. There are two ways in which we can recognize electricity. First, we can see it at work, especially at night, as in connection with the trolley of the street car or with the car rails. Second, we can feel this force when it enters the hands or any part of the body.

There are three ways of generating electricity, and these will be explained to you by some simple experiments which you can perform at home or school.

First way, by friction.

Experiments

1. Rub your feet along on a Brussels carpet, then touch the forefinger to a piece of metal. If the atmosphere is sufficiently dry, a spark of electricity will pass from the finger into the metal.
2. Stroke the fur of a cat, and hear the crackling sound. Take puss into a dark room, and notice the electric sparks.
3. Heat a piece of paper over the lamp for a moment, and then draw it quickly two or three times between the coat and the coat sleeve. Now place the paper against the side of the wall. What takes place? Why?
4. Make two or three pith balls, the size of a marble, from the stem of a sunflower or the stalk of an elder bush, and suspend these six inches apart, by the use of silk threads. Paper balls will do if you can not secure the pith. Rub a glass rod, or a long glass bottle, with a silk handkerchief, and bring it near one of the pith balls. What happens? Why is it first attracted, then repelled? Touch the ball, and repeat the experiment.
5. Rub a bar of sealing wax, or a rubber comb, with a piece of dry flannel, and observe the action of the pith ball when either of them is brought near. Run the comb several times through your hair, if it is dry, and then bring it near the ball.
6. Rub the glass rod, and touch the ball. After the touch, it is *repelled*. Now rub the sealing wax, and bring it near the

ball. It is *attracted.* Why? Touch the ball with the hand, and rub both the glass and the wax, and at the same time place one on each side of the ball. What happens?

PITH BALL ATTRACTED BY ELECTRICITY

7. Bring each of these, in turn, close to a magnetic needle, and see if the electricity in the glass is like that in the wax.

In the above experiments, the electricity is produced by rubbing, or friction. You found that the glass rod had one kind of electricity, and the sealing wax or rubber comb had another. The balls were charged when touched by either. When you touched the ball with the hand, it lost its electricity, which went into your hand, and you could perform the experiment again.

In your study of magnetism, you found that there are two kinds. The kind at one end of the magnetic bar is called *negative,* and is represented by the minus (—) sign. That at the other end is represented by the plus (+) sign, and is called *positive.* The positive end of the magnetic needle always points to the north. You also learned that the positive pole of a magnetic bar brought near the positive end of a magnetic needle would repel it, and that the negative pole brought near would attract it. From these actions, we learn the law of magnetism to be this: —

PITH BALL REPULSED BY ELECTRICITY

Like signs repel, and unlike signs attract.

8. Magnetize a darning needle by drawing it a few times across a magnet, and then place it on a piece of cork in a basin of water, as shown in the illustration. Now place one pole of the magnet near one end of the needle; now the other pole. What occurs? Present both poles of the magnet to the other end of the needle. When the magnet is taken away, what line of direction does the needle take? What does this prove the needle to be?

This same law, you saw by your experiment with the glass rod and the beeswax, applies to the action of electricity.

Now place the three pith balls an inch apart, and use both the glass and the wax, and see how curiously they behave. Their behavior will prove the truthfulness of the law you have just learned.

9. Place one end of a yardstick upon a bottle, and the other upon the electroscope. Now touch the farther end of the yardstick alternately with the glass rod and the beeswax, and note the effect upon foil or paper. How does the electricity reach the electroscope? Try the same experiment, connecting the bottles by using a long glass rod or rubber strip.

This shows that electricity, like heat, will pass through substances; and we find that good conductors of heat are good conductors of electricity, and poor conductors of heat are poor conductors of electricity.

PITH BALLS REPELLING EACH OTHER

Second way, by chemical affinity.

Experiments

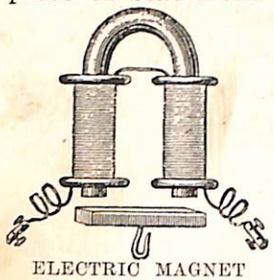
1. Place a copper cent upon the tongue, and a piece of zinc beneath it. Describe the sensation in the tongue. This is a simple electric cell.

2. Obtain from the hardware store a strip of copper and one of zinc, each strip two inches wide and six inches long. Place these in a tumbler two thirds full of dilute solution of either sulphuric or hydrochloric acid and water. There should be six parts of water to one of acid. Connect the upper ends of these strips with a short piece of insulated copper wire. What agitation do you observe in the tumbler? Examine the ends of the metal strips in a short time. This is a simple electric cell, and the electricity is produced by the acid. The copper strip does nothing but act as a conductor, gathering up the electricity produced by the zinc, sending it on into the copper wire, and returning it to the cell through the zinc strip. Carbon plates are often used

instead of copper, as they are less expensive. The copper or carbon is called positive (+) and the zinc negative (—).

The affinity of the acid for the zinc causes chemical action, which results in heat and electricity. The dip battery has a contrivance for lifting the zinc plate out of the acid when the battery is not in use, and this is held above the solution by a thumbscrew. This device is economical, as zinc is quite expensive. Notice that the tumbler becomes warm in a little time. The electricity produced in this way is called voltaic electricity, after Mr. Volta, who discovered this method of generating it.

3. Wrap the copper wires attached to the strips around a piece of soft iron. The iron becomes a magnet, and will attract iron filings, pins, and tacks. When the current stops flowing, then the iron ceases to be a magnet, and will not attract. This is the plan used in running street cars. The current can be turned on and off quickly, thus making magnets and then unmaking them. All the machinery under the car is so arranged with magnets, springs, wire coils, and cogwheels connected with the wheels of the car, that when the current is turned on, the car is set in motion. This electric machinery is called a *motor,* because it sets things in motion.



ELECTRIC MAGNET

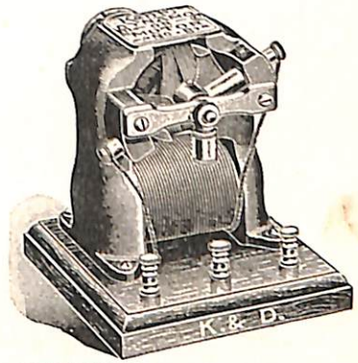
4. Arrange the copper wire parallel to the needle of a compass as it lies at rest pointing northward. Bring the ends together, and notice how the current turns the needle at right angles. Open and close the circuit several times. It is supposed that the sun causes a current of electricity to flow continually around the earth from east to west, and that causes the magnetic needle to lie north and south.

Third way, by revolving a wire coil about a magnet.

Just how this produces electricity is not known. It is certainly very interesting to see how closely magnetism and electricity are related to each other. They are like twin brothers, and seem to work industriously and harmoniously together. The electric current, when passed through wires around a piece of soft iron, produces magnetism; and now if you set the wire coils to revolving about a magnet, it produces electricity.

The large part of electricity used in street car service, electric lights, and in manufacturing concerns, is produced in this way, and the machine producing it is called a *dynamo,* which means *power,* the same as "dynamite."

This powerful force, electricity, is certainly interesting to study, even though it is not easy to understand. It is not expected that this study of it will be your last, for you will come to it again when you take up the study of physics later on. It will be more easily understood then because of what we have learned at this time.



DYNAMO FOR GENERATING ELECTRICITY

Questions

1. What is magnetism? How are magnets made? Give the law of magnetism.
2. What is electricity? Does man create it, or generate it? What is the difference?
3. What is the law of electricity? Compare electricity and magnetism and their laws.
4. In what three ways is electricity generated?
5. What is an electroscope? Electric cell? Motor? Dynamo?
6. Name good conductors of electricity. Poor conductors.
7. Why are glass and porcelain supports used to hold electric wires?
8. Why do electricians often wear rubber shoes and gloves?
9. Why are electric wires often covered with cotton, silk, or other material?
10. Name the two kinds of electricity. Why are they so called?
11. How fast does electricity travel? Compare its velocity with that of light.
12. What beings are said to move with lightning speed? Eze. 1: 14.
13. How long was Gabriel coming from heaven to earth? Dan. 9: 21, 22.

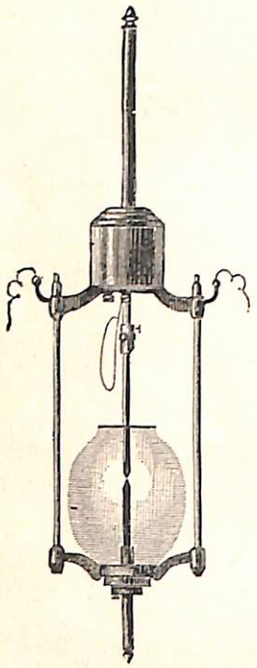
Note Book Requirement

Explain the illustrations on pages 64, 65.

Electricity and Magnetism at Work

Canst thou send the lightnings, that they may go, and say unto thee, Here we are? Job 38: 35.

These twin brothers are almost always found working together. We learned, in the previous lesson, that they help each other out wonderfully. If magnetism is running short of power, or getting weak, his brother, electricity, embraces him, and revives and reinforces his waning energies. If electricity is fagging out, then his brother, magnetism, exercises his magnetic power, and he goes by leaps and bounds along his wiry circuit.



ARC LIGHT

Magnetism operates the mariner's compass, and thus makes it possible for ships to travel with certainty across the pathless oceans. The compass is also of great value to travelers by land, especially to surveyors working in new country, on cloudy days, when the sun is hidden behind clouds.

Electricity alone operates the electric lights. There are two kinds, the *arc* and the *incandescent*.

The arc light was invented about one hundred years ago. It is made by the current passing over a break in the wire. The ends of the wire became so heated that they would melt, and therefore carbon is used, where the wires are separated, to resist the "burning" caused by the intense heat of the "arc." The arc light has been used a great deal for lighting the streets of cities; but its light is not steady, and is now being largely superseded by the incandescent light. "Incandescent" means *glowing*. The incandescent

light is produced by passing electricity through a carbon or metal wire placed in a glass bulb from which the air has been taken. There being no air in the bulb — which means no oxygen — the wire can not burn, although it is caused to glow and give light.

It is interesting to visit an electric light plant, and see the dynamo generating the electricity which is sent through wires throughout the city. Notice the switchboard where the current is turned on and off as desired. You must be very careful to heed the danger signals that are placed about the plant, or you may touch a *live* wire. A live wire is one that is charged with electricity; and often it is charged, or loaded, so heavily with the electric current that instant death is caused by touching it.

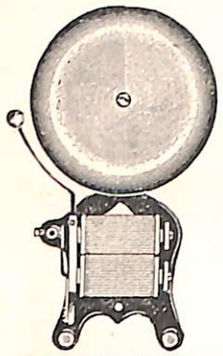
INCANDESCENT LIGHT

Electric bells are very common and interesting articles. Of course they are very serviceable. Magnetism and electricity unite in operating these bells. A magnet is made in a bell by a current of electricity passing through a coil of wire wrapped around a piece of soft iron. The magnetism lasts only while the current is in the coil.

When the current is on, the magnet pulls the hammer against the bell; but when the hammer is almost there, the current is broken by means of a spring connecting with the hammer. The hammer strikes the bell and springs back, restoring the circuit, and causing the electricity to flow again through the coil. The magnet then pulls the hammer again. This operation is repeated as long as the supply of electricity lasts, and the hammer keeps striking the bell, causing it to ring.

Electricity is used more and more every year in the homes of the people. It is taking the place of fuel,— wood, coal, and gas, as well as gasoline and kerosene. Many people believe that some day electricity will entirely replace coal and wood, so

that there will be no need to work coal mines, and to preserve our forests, as the mineral world will furnish material for building our houses. But we should not forget that there must be some power to run the dynamos that supply the electricity. Coal and wood and oil are now used for heating water to provide steam to operate the engines that run the dynamos. This fuel is all we have to furnish power, except in places where water power is sufficient, as at Niagara Falls, and other falls and rapids throughout the world.



ELECTRIC BELL

Notice in what ways electricity is taking the place of fuel in our homes. We now have the electric heater for warming rooms, the electric cooker for cooking food, and the electric iron for ironing our clothes.

There are now in progress experiments with electricity along a new line. It is used with remarkable results in producing rapid growth in vegetation. Soil that has been charged with electricity will cause more rapid germination of the seed, and an earlier development of the plant.

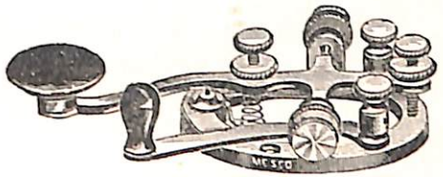
But the most wonderful use of these two mysterious forces is illustrated by telephone and telegraph instruments. By these it would seem that the question of the Lord to Job is answered: "Canst thou send lightnings, that they may go, and say unto thee, Here we are?"

What long distances, and with what amazing rapidity, messages are sent across oceans and continents! It is not necessary now even to have wires to send them, since wireless telegraphy was invented. A message from one station speeds through the air, and is picked up by another station.

Like the electric bell, the electric telegraph is based on the principle of the electro-magnet. The following experiment will show how it operates:—

Experiment

Procure a good dry cell, twenty feet of No. 20 cotton-covered magnet wire, a large nail, and a smaller nail. Wind the wire upon the large nail, in smooth layers. Remove the covering from the wire at one end, and attach the wire to one end of the small nail. Fasten the other end of the wire coil to one pole of the dry cell, and connect a short piece of wire to the other pole of the cell. Arrange the small nail so that it lies across the end of the large nail, separated from it about 1-16 of an inch. Touch the connecting wire to the small nail, and it is immediately attracted to and held by the large one. Break the circuit, and the nail is released. Closing and opening the circuit clearly illustrates the operation of the Morse telegraphic key and sounder.



TELEGRAPH KEY

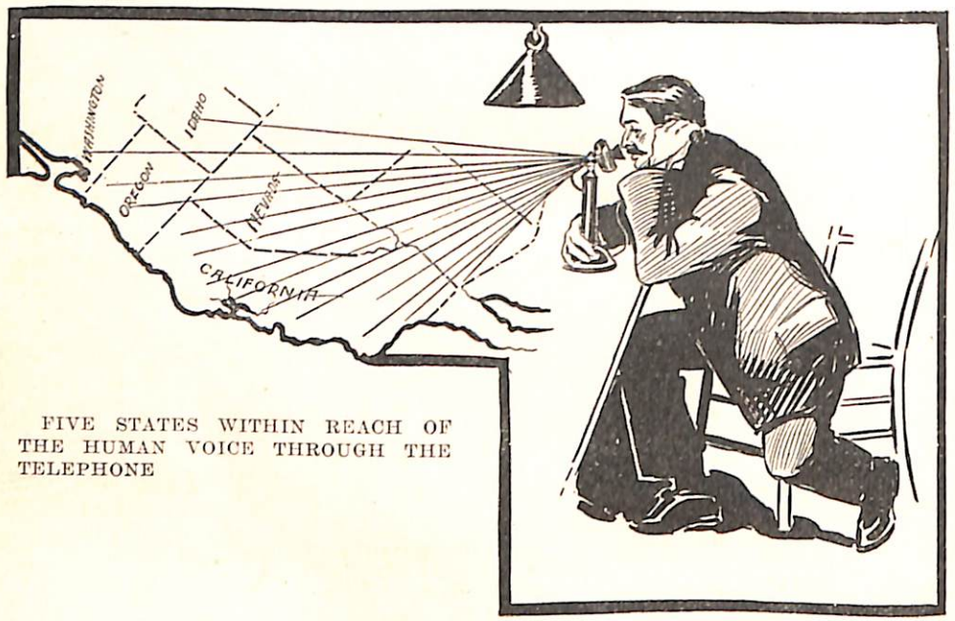
The telegraphic alphabet was invented by Robert Morse. It consists of a series of dots and dashes, with spaces between the letters, and longer spaces between words. The first telegraph instruments made records on strips of paper; but now messages are usually read by sound. We give here the Morse alphabet:—

A . —	G — — .	M — —	S . . .
B — . . .	H	N — .	T —
C — . — .	I . .	O — — —	U . . —
D — . .	J — — — —	P . — — .	V . . . —
E .	K — . —	Q — — . —	W . — —
F . . — .	L . — . .	R . — .	X — . . —
	Y — . — —	Z — — . .	

The telephone in some respects is more wonderful than the telegraph. While it can not be used for such long distances, yet a conversation between two persons can be carried on for hundreds of miles. The telephone instrument is more complex than the telegraph, and it is operated by both magnetism and electricity.

When you speak into a telephone, the sound strikes an iron disk and makes it vibrate. This causes a wavy current of elec-

tricity to flow through the wire, and makes an iron disk at the other end of the line vibrate in a similar way. You should examine a telephone instrument, and learn exactly how it operates. Perhaps you have one in your home. If so, ask your father to explain to you how it works. You will find a simple



FIVE STATES WITHIN REACH OF THE HUMAN VOICE THROUGH THE TELEPHONE

telephone which does not require electricity or magnetism explained in lesson 14.

A knowledge of magnetism and electricity must be included in the knowledge which Daniel said should increase in the last days. It has not been given that man should use it selfishly for himself, but to make possible the rapid spread of the knowledge of the gospel to all nations, tongues, and peoples, that they may be ready to meet the Lord when He comes.

It is interesting to study the wonderful things in God's creation; but how much more interesting it will be to study them

in the school where Christ, who made them, and the angels, who have so long studied them, will be our teachers! Let us live so we may be enrolled in that heavenly school.

Questions

1. How closely are electricity and magnetism related to each other?
2. What useful instrument is operated by magnetism alone? By whom is it used, and for what purpose?
3. What instruments are operated by electricity alone? Name the two kinds of electric lights. Why are they so named? Give examples of each kind, and explain their construction.
4. Describe your visit to an electric light plant. Why are danger signals placed in different places in such a plant?
5. Tell how electricity is used instead of fuel,— wood, coal, and gas.
6. How is electricity used by the agriculturist?
7. Name instruments operated by both electricity and magnetism.
8. Of what value are the electric bell, the telegraph, and the telephone?
9. Who invented the telegraph? The telegraph alphabet? How is it written and read?
10. How is the question in Job 38:35, which the Lord asked Job over three thousand years ago, now answered? By what means?
11. Why have so many wonderful things been invented in these last days? Who foretold that it would be so? Dan. 12:4.

Note Book Requirements

1. Make diagrams showing the mechanism of the telephone and the telegraph, or write a description of each, on pages 66, 67.
2. Describe on page 68 the electric light and bell.

Composition of Matter

The Lord hath made all things for Himself. Prov. 16: 4.

Of what is all matter made,— the water, the dry land, the air, and every substance that we find above, beneath, or upon the surface of this earth?

The study of matter in which one attempts to find out the substances of which everything is made, is called *chemistry*, and the men who spend their lives in such study are called *chemists*.

Hundreds of years ago, before much study had been given to this subject, people believed that all things were made from just four substances,— earth, air, fire, and water. These four substances could apparently be separated or divided into nothing simpler. Earth was just earth, air was just air, fire was just fire, and water was just water.

By study and experiment, however, chemists began to learn that this was a mistake. They found that the earth is composed of many different kinds of substance. And they found a power which was able to separate water into two distinct things. What is that power? What are the two substances of which water is composed? Air, they learned, was a mixture chiefly of nitrogen and oxygen. Carbon dioxide consists of carbon and oxygen; salt, of sodium and chloride; sugar, of oxygen, hydrogen, and carbon. Alcohol, starch, and many other organic substances in the plant and animal world are made of the same elements as sugar, only the atoms of these elements unite in different proportion in each substance. A molecule of alcohol has nine atoms, as follows: carbon 2, hydrogen 6, oxygen 1. The chemical symbol is $C_2 H_5 OH$. A molecule of starch has 21 atoms, $C_6 H_{10} O_5$; one of sugar, 45 atoms, $C_{12} H_{22} O_{11}$.

Such substances as gold, oxygen, hydrogen, nitrogen, copper, tin, lead, silver, sulphur, and other substances which chemists have been unable to separate, or divide into different substances, are called *elements*. No chemist, so far, has been able to separate or divide hydrogen into different elements, as water was

long ago separated. Neither has any means been found for separating gold, lead, tin, silver, copper, zinc, or sulphur into different elements.

Up to the present time, chemists have discovered in all about eighty elements, and almost every year some new element is found, which shows us how much more there is to learn about God's wonderful works in the field of chemistry.

The chemist chooses the materials best suited to the substance he is about to prepare, but he can not create these materials. His wisdom and skill are shown in the selection and combination of materials. The Creator's wisdom and power are shown in the *creation* of the materials which He uses, and in giving each substance just those characteristics and properties that adapt it to the purposes it was made to serve. Surely God is the Master Chemist.

Questions

1. Define matter.
2. What is the science called in which one attempts to find the different substances of which everything is made?
3. Who are chemists?
4. What did people once believe concerning the substances found in nature?
5. How did they discover that they were mistaken?
6. Of what elements is water composed? Air?
7. Name the elements composing salt, sugar, starch, and alcohol, and give the number of atoms found in a molecule of each of these substances.
8. Define the term "element," and name twenty of the most common elements.
9. How many elements have been discovered?
10. What shows God to be the Master Chemist?

Chemical Compounds

Thou hast created all things, and for Thy pleasure they are and were created. Rev. 4:11.

In the world there are millions of different things, but it has been discovered that all these things are made by a proper grouping or combining of the different chemical elements.

In the English language there are over 200,000 words, but all these different words are formed from an alphabet of twenty-six letters. By grouping these letters in the proper order, we form the different words of the English language; and by grouping the chemical elements, the Great Chemist in the beginning formed the numerous substances in nature about us. For this reason the chemical elements have very appropriately been called *the alphabet of matter*.

The combining of the letters of the English alphabet forms English words, while the combining of the chemical elements of the alphabet of matter forms material substances which are called *chemical compounds*.

In a chemical compound, the atoms of different elements combine in such a way that the identity of the elements thus united is lost, and an entirely new substance is formed. When the substances or elements do not lose their identity, but are simply mixed together, we have what is called a mixture. Take the chemical elements hydrogen and oxygen, and allow them to combine themselves in the proper proportion, and the result is water, a very familiar chemical compound. This compound is a liquid, while the elements which form it are gases.

Experiments

1. Take some iron filings and mix them with sulphur. Heat the mixture thoroughly, and the atoms of iron combine with the atoms of sulphur, so that the identity of the iron and the sulphur is lost. The heat has changed the mechanical mixture to a liquid. Use an alcohol lamp in heating. After cooling, the new compound may be crushed to a fine powder; but although the

powder be examined with a magnifying glass, no small particles of either iron or sulphur can be discovered. Before heat was applied to the mechanical mixture, the substances remained unchanged, and could be separated by a magnet. Now attempt to separate the iron and the sulphur as before. What is the result?

2. Sulphur and potassium chlorate, when powdered and mixed, may be changed to a compound by the application of pressure. Secure from the druggist a little powdered sulphur and powdered potassium chlorate. Mix a small pinch of these two powders together, and place this mixture upon an anvil or some smooth metal surface, then rub it with the back of an ax or the head of a hammer. What is the result?

3. (*To be performed by the teacher only.*) Take a small piece of phosphorus (cut it under water, or it will burn the fingers) and a pinch of powdered sulphur, and wrap them in a small piece of tissue paper, making the whole about the size of a pea. Place this little packet on an anvil or metal surface, and strike it a quick blow with a hammer. What is the result? What causes the sharp explosion when the trigger of a toy pistol strikes the thin paper cap?

4. Take a tablespoonful each of powdered loaf sugar and powdered potassium chlorate, and mix them thoroughly. Spread this mixture out very thin on an old worthless plate or tin. Dip a small rod into a bottle of sulphuric acid, and hold it horizontally over the powdered mixture without touching it. What happens? Now allow a drop of the sulphuric acid to drop on the powdered mixture. What takes place?

In the above experiments, you made, first, *mechanical mixtures*. But when *heat* or *pressure* was applied, then the atoms united with one another, sometimes with an explosion, and you had a new substance called a chemical compound.

The following experiment shows how the chemical affinity of a chemical compound is destroyed by heat, and the substance is separated into its elements:—

5. Take a little mercuric oxide (a red powder), and place it in a bottle. Apply heat, and the compound will be broken up. The mercury will adhere to the sides of the bottle, and the oxygen will escape as gas. Test the oxygen by placing in the bottle a lighted splinter, just blown out, which will again burst into a blaze.

Familiar examples of chemical compounds are all about us. The sugar we use on our tables, the salt with which we season food, our foods themselves, as well as every tissue of our bodies, are but combinations of the chemical elements of matter.

When we study the elements and compounds, and find how they are put together in the earth, we are studying the works of an infinitely wise and all-powerful Creator, whom to know is life eternal.

Note Book Requirements

1. On page 38 explain what is meant by the expression "alphabet of matter."
2. On page 39 define the expressions "element," "chemical compound," and "mechanical mixture."
3. Write a list of chemical compounds, and a list of mechanical mixtures.

The Affinity of the Atoms

When the atoms and molecules cling tightly together, a *solid* is formed.

When the atoms and molecules do not cling tightly, a *liquid* is made.

When they so repel each other that they will not stay close together, a *gas* is formed.

This attraction and repulsion of the atoms is seen constantly in the things about us. A nail left out-of-doors will soon rust. This is caused by the little atoms of oxygen in the air being attracted to the iron composing the nail.

The fire in the stove is caused by the atoms of oxygen in the air having an attraction, or affinity, for the atoms of carbon in the wood.

If you open a bottle of ammonia water, the room is soon filled with its odor. The atoms of ammonia repel each other so much that they will not remain together in the bottle. Oranges and other fruits soon fill the room with their fragrance.

When powdered potassium chlorate is carefully mixed with sulphur, the small atoms of sulphur have an attraction for the atoms of potassium chlorate; but this attractive power acts only at a very short distance; therefore it is necessary to push the atoms near to one another before they will rush together.

If you dip a piece of zinc into sulphuric acid the acid seems to boil upon the surface of the zinc. This is caused by the atoms of zinc and sulphuric acid rushing violently together.

All these things are exhibitions of the power of God. The tiny atoms are under His control, and act in harmony with the laws made for them by the great Creator.

Questions

1. Describe and give examples of the three conditions of matter.
2. Describe and illustrate the general and specific properties of matter.
3. Describe the attraction and repulsion of atoms.
4. What is the alphabet of matter?
5. What are the elements?
6. Define a chemical compound.
7. What are mechanical mixtures?

Note Book Requirements

1. On page 35 write an answer to question 1.
2. On page 36 write an answer to question 2.
3. On page 37 write an answer to question 3.

The Earth's Rocky Frame

Through faith we understand that the worlds were framed by the word of God. Heb. 11: 3.

"Where wast thou when I laid the foundations of the earth? declare, if thou hast understanding. Who hath laid the measures thereof, if thou knowest? or who hath stretched the line upon it? Whereupon are the foundations thereof fastened? or who laid

the corner stone thereof; when the morning stars sang together, and all the sons of God shouted for joy?"

"Bless the Lord, O my soul. O Lord my God, Thou art very great; Thou art clothed with honor and majesty; . . . who laid the foundations of the earth, that it should not be removed forever."

"The earth is the Lord's, and the fullness thereof; the world, and they that dwell therein. For He hath founded it upon the seas, and established it upon the floods." "The Lord by wisdom hath founded the earth; by understanding hath He established the heavens."

"He hath made the earth by His power, He hath established the world by His wisdom, and hath stretched out the heavens by His discretion."

In these words from the Bible we learn that God framed our world, and that He laid its foundations by His great power, wisdom, and discretion. We have spent much time in studying the visible portion of the earth, but very little time in studying its foundations. But this was a very important part of the work of the Creator.

In building a house, it is important that it be provided with a firm, strong foundation, in order that the building may be well supported. You have seen buildings out of shape, tipped to one side, or falling down, because the foundation was not stable. Not so with the foundation that was laid for this world. David says that God "laid the foundations of the earth, that it should not be removed forever."

We can not penetrate into the earth very far without striking solid rock. Some of the mine shafts have been sunk into the earth two or three miles; but that distance is almost nothing compared with 4,000 miles, the distance to the center of the earth.

The study of the foundation of the earth is called *geology*, and the men who devote their time to the study of this science are called *geologists*. Some geologists have caused fear and alarm in the minds of some people by telling them that the foundation of the earth is unstable. They claim that because the temperature increases as we descend into the earth, its interior is a molten, fiery mass; that in some places the earth's crust is very thin; and in proof of their claims, they refer to the volcanoes. But in Book 2 we have learned that this is not the cause of volcanoes.

Men know very little about the foundation and framework of the earth; and God says to those who profess to know much, "Where wast thou when I laid the foundations of the earth? declare, if thou hast understanding." Men have seen but little into the depths of the earth, and know but little concerning its foundation. Their ideas are only guesses. How much wiser it is for us to listen to what God says of it in His word, and not act as if we knew what God says we do not know!

The idea that the earth is a ball of fire with a thin crust of earth surrounding it, is a false alarm. The later geologists do not teach this, but they say the earth is a solid globe to its very center. But the Bible does give an alarm that all should heed. It tells us of a time when the wicked shall be destroyed by fire that will envelop the earth, destroying all the wicked and their evil works. But this fire comes down from heaven, not from the inside of the earth.

David expresses confidence in God's keeping power, when he says: "In His hand are the deep places of the earth: and the strength of the hills is His also." "God is our refuge and strength, a very present help in trouble. Therefore will not we fear, though the earth be removed, and though the mountains be carried into the midst of the sea; though the waters thereof roar and be troubled, though the mountains shake with the swelling thereof."

God's word plainly declares that just before Jesus comes, there will be great commotion in the earth, in the sea, and in the air. John the revelator describes the condition of the earth under the seventh plague: "And every island fled away, and the mountains were not found."

While the earth is to be shaken and the mountains will disappear, yet on the same original foundation, after all sin has been removed and sinful works have been destroyed, God will renew the earth, and it will appear in Edenic beauty.

The face of the earth was greatly changed by the flood. Before that time, the foundations of the earth were not visible. The rocks which served as bones to the earth were covered with soil to the tops of the highest mountains, and these were covered with beautiful vegetation.

David speaks of a time when God visited the earth in wrath, and the commotion was so great that the foundations of the earth were discovered: "The Lord also thundered in the heavens, and the Highest gave His voice; hailstones and coals of fire. Yea, He sent out His arrows, and scattered them; and He shot out lightnings, and discomfited them. Then the channels of waters were seen, and the foundations of the world were discovered at Thy rebuke, O Lord, at the blast of the breath of Thy nostrils."

There are a number of instances mentioned in the Bible when the earth, or portions of it, have been greatly convulsed, besides the time of the flood. When God came down on Mount Sinai, "the earth shook, the heavens also dropped at the presence of God." When Christ yielded up His life on Calvary, "the earth did quake, and the rocks were rent."

Micah's prophecy against Israel shows that the earth would be afflicted because of their transgressions: "Hear, all ye people; hearken, O earth, and all that therein is. . . . For, behold, the Lord cometh forth out of His place, and will come down, and tread upon the high places of the earth. And the mountains shall be molten under Him, and the valleys shall be cleft, as wax before the fire, and as the waters that are poured down a steep place. . . . I will pour down the stones thereof into the valley, and I will discover the foundations thereof."

In the light of these statements of the Scriptures, the broken up and irregular appearance of the face of the earth is easily

accounted for. Sin has brought it all. Not only man, but the earth, has suffered for the sin of our first parents, and in consequence it is marred and scarred everywhere. It still suffers from the visitations of earthquakes and volcanic eruptions; and truly, as the Bible declares, "the whole creation groaneth and travaileth in pain together until now."

Long ago Job said, "Speak to the earth, and it shall teach thee." What will it teach us? What lesson does the geologist learn and pass on to others, from his study of the foundations of the earth,— the rocks, the stones, the plant and animal fossils that he finds buried in the earth? The greatest and most important lesson he should learn is the terrible results of sin,— that it has blighted the whole earth, and that man, and all forms of life, have greatly degenerated and deteriorated under the reign of sin and death.

In all the relics unearthed, we have undeniable witness and testimony to the truthfulness of the Scriptures. The Bible is the only true history of our world that men possess. This being true, we should learn its lessons well, that we may live on this same earth restored, whose foundations will not be destroyed, but only sin, sinners, and their sinful works.

Questions

1. How were the worlds framed? How do we know this?
2. What part of the earth are we now to consider? What is it called in the Scriptures? Job 38: 4-7; Ps. 104: 1, 5; 24: 1, 2; Prov. 3: 19; Jer. 10: 12.
3. What is the study of the rocks or foundations of the earth called? What name is given to men who study them?
4. How much does man know about the earth's foundations? What false teaching is given by some geologists? How do we know it is false?
5. Has the earth ever been destroyed? How? Will it be destroyed again? When and how?
6. Were the foundations destroyed by the flood? Will they be destroyed by water? What is the assurance? Ps. 104: 5.
7. What was the condition of the earth when it was created?

8. Describe visitations of God's power in shaking the earth, and the results. Ps. 18:7, 13-15; 68:8; Matt. 27:51; Micah 1:2-4, 6.
9. What lessons should the earth teach to the geologist? What is the most important lesson of all?
10. What is the condition of the earth now? For what is everything in nature waiting? Rom. 8:22.

Kinds of Rock

For who is God, save the Lord? and who is a rock, save our God? 2 Sam. 22:32.

We learned in our last lesson that the rocks were entirely covered by the soil when God completed the work of creation week. By the end of the week, He had a garden planted and growing, and some of its trees were so far matured that they provided man with fruit. Thus God not only made rocks, but soil, during the first week of time. These were created by Him the same as were the light, heat, air, and water.

At the time of the flood, the earth was convulsed, and the fountains of the great deep were broken up. It is probable that there was more water inside the earth before the flood than there is now; and consequently there is more water on the outside of the earth than God planned for in the beginning.

As the rocks were thrown out upon the surface of the earth, much of the soil was covered up. We have no reason to believe that the foundation rocks were of more than one kind. Undoubtedly the precious stones and metals were upon or near the surface of the earth. But when its surface was broken up at the time of the flood, the precious stones and metals were buried.

Geologists have classified the rocks into divisions based on their formation and structure. On account of so much of the original soil being buried by rocks and mountains, God has provided means for the manufacture of more soil, and also for distributing it over the earth's surface. This soil is made by breaking up the rocks, or pulverizing them, by various agencies He has provided.

We will now learn the names of the different kinds of rock:—

1. *Archæan Rock.*— This is supposed to be the oldest rock,— the original rock. The word means *the beginning.* This kind of rock is not common, because that which is near the surface has undergone changes through the action of heat, water, and pressure.

2. *Sedimentary Rock.*— These rocks are formed from the sediment that is washed down the hillsides by the rain, and then carried by streams and rivers into the lakes and oceans, where it settles, forming layers on the bottom, which in time harden into rock. Where the layers are visible in the structure, the rock is called *stratified* rock.

3. *Igneous Rock.*— Melted rock that has come from the interior of the earth and spread over its surface, or filled crevices and caverns below the surface, is called *igneous* rock. The word means *fire,* and from it we get our word "ignite." When this molten material cools gradually, a *crystalline* structure is the result. *Granite* is a good example of crystalline igneous rock. When the mass cools very rapidly, the same material produces *obsidian,* which is a natural glass rock. When the same material is blown out of a volcano by the action of steam, *pumice,* or volcanic ash, is formed. This makes excellent soil for the growing of wheat. Large areas of the wheat belt in the states of Washington and Oregon consist of this kind of soil.

4. *Metamorphic Rock.*— When rocks have been subjected to the action of heat, or great pressure, or both, certain changes take place in the structure of the rocks. This change is called *metamorphism.* As examples of metamorphic rock, we mention *quartz,* which, before the change took place, was *sandstone. Shale* rock is changed to *slate.* Coal, in some cases, has been changed into *graphite,* which is pure carbon. Under the influence of heat and pressure, many rocks have their nature greatly changed.

5. *Chemically Formed Rocks.*— Nearly all rocks are formed beneath the surface of the earth. We have a visible example of rock making about hot springs and geysers. The hot water flowing through the mineral beds dissolves portions of them. When the water reaches the surface and cools, the mineral is released, and the result is the formation of stalactites in caverns, calcareous *tufa* around hot springs, and silica around the geysers of the Yellowstone Park.

6. *Æolian Rocks.*— You have heard of æolian harps played by the wind. Well, the æolian rocks are formed by the wind picking up pebbles and sand and blowing them into nooks and hollows. In the course of time these beds become very large; and the great pressure produced, and the presence of some cementing material, cause these large beds of sand and pebbles to be solidified into rock.

There are other kinds of rocks which are but a combination of those above described, and they can not be very readily classified.

On the surface of the earth are found loose rocks, called *mantle rock,* because of forming a mantle over the surface of the earth. Beneath these is the solid rock, which has not been loosened, and is called *bed rock.* Rocks which have been carried by streams or other means are called *transported rock.*

This lesson will give you a knowledge of the different kinds of rocks, and why they are so named; but there is something for you to learn concerning them which is far more important than their names and how they are formed.

The nature and character of the rock teaches very important lessons. The rock is solid and stable and very hard to move. And we are exhorted in the word of God to be "steadfast, unmovable, always abounding in the work of the Lord." What is more unchangeable and unmovable than a rock? Both God and Christ are symbolized by the rock, because of Their unchangeable characters It is declared of Them, "I am the

Lord, I change not; therefore ye sons of Jacob are not consumed." "Jesus Christ the same yesterday, and to-day, and forever."

Let us be firm as a rock in character. Under heat and pressure, the sandstone becomes clear and transparent crystal, and the limestone becomes beautiful marble. Let us likewise, under the heat and pressure of trial and temptation, become beautiful stones, fit for a place in the temple of the Lord.

Questions

1. What was the condition of the earth's surface in the beginning?
2. How was it affected by the flood?
3. What was necessary to replenish the soil? How is this done?
4. What are the principal kinds of rocks, and how are they formed? Give examples of each.
5. What influence do heat and pressure have on rocks already formed? What lesson can we learn from this?
6. Of what is the rock a symbol?
7. In what way is it a symbol of God and Christ? Mal. 3:6; Heb. 13:8.
8. In what way are we to be like the rock? 1 Cor. 15:58; Isa. 32:2.

Rock Breakers and Makers

And, behold, the Lord passed by, and a great and strong wind rent the mountains, and brake in pieces the rocks before the Lord; but the Lord was not in the wind: and after the wind an earthquake; but the Lord was not in the earthquake: and after the earthquake a fire: but the Lord was not in the fire: and after the fire a still small voice. 1 Kings 19:11, 12.

Some geologists think it has taken ages upon ages to make the changes that have been made on the earth's surface; but if they had witnessed such a scene as Elijah witnessed in the rending of the mountains and the breaking of the rocks, they would see that the Creator can produce great changes in His creation in a very short space of time.

The Bible tells us that in the last days persons would scoff at the idea of Christ's soon coming, and the destruction of the earth by fire, saying, "Where is the promise of His coming? for since the fathers fell asleep, all things continue as they were from the beginning of the creation." They will not admit of any extraordinary manifestation of the power of God to destroy or disfigure the earth. It is said of these scoffers, "This they willingly are ignorant of, that by the word of God the heavens were of old, and the earth standing out of the water and in the water: whereby the world that then was, being overflowed with water, perished." They will not admit there was a flood that deluged the earth. through a mighty manifestation of creative power.

The antediluvians reasoned the same way as these scoffers do now, and they were overtaken and destroyed by the flood. The apostle Peter continues his prophetic warning, based on the never failing word which foretold the destruction of the flood, by saying, "But the heavens and the earth, which are now, by the *same word* are kept in store, reserved unto fire against the day of judgment and perdition of ungodly men." Then to show that time is not a necessary factor at all in God's accomplishing His work, he says, "But, beloved, be not ignorant of this one thing, that one day is with the Lord as a thousand years, and a thousand years as one day." In other words, that which geologists think would require a thousand years to accomplish, God can do in one day of twenty-four hours; or if He please, He can take a thousand years to perform what He could do in one day. Peter would have scientists, and especially geologists, understand that God is not limited in any degree by time in the carrying out of His plans.

This theory of long, indefinite time has been originated by the archdeceiver, and applied to the days of the creation week, making each day ages upon ages in length. One purpose in this is to get rid of the seventh day as the Sabbath of the Lord

which men should observe. But we need not and *can not* be deceived so long as we are guided by the great Book of truth.

In this lesson we shall consider the ordinary ways of God's working in breaking up the rocks to provide new soil; and also how new rocks are made so the rock supply may not diminish. The following are a few of the agencies for breaking the rock into small pieces:—

1. *Water.*— You may have heard the old saying, "The continual dropping will wear away the stone." The falling rain upon the rocks tends to loosen the particles on the outside. Many rocks are porous, and allow the water to soak into them. The running water in brooks and rivers, also the water beating against the rocks that border the lakes, seas, and oceans, wear away the rocks, making them smooth and round.

2. *Heat and Cold.*— Heat expands the rock, and the water in it, so that pieces split off and drop down, breaking into smaller pieces.

Cold causes the water in the rocks and in the crevices of the rock to freeze. This freezing causes expansion, and thus the rock is broken up into smaller pieces. This constant action of water, heat, and cold, winter and summer, year after year, wears off, breaks up, and pulverizes great quantities of rocks and stones for soil purposes.

3. *Wind.*— Perhaps we have not thought of wind as an agent for breaking rocks, but it is a powerful one. When the air is in rapid motion, it picks up sand and small pebbles, and hurls them against rocks and mountains, wearing them away slowly but surely. Each grain of sand and each pebble becomes a sort of chisel, cutting off a grain here and there from the mountain sides. In sandy districts, telegraph poles and fence posts have been cut off by the action of blowing sand. The rain washes the severed grains of rock, and they are rushed onward by rills, brooks, and rivers, and finally deposited in the valley below.

Now let us consider how rocks are made. We have already indicated how some are made by heat and pressure; but these

were made of rock material thrown out of the interior of the earth, or brought from mountains in the form of sand and pebbles. But you will be interested to know that plants and animals contribute to rock making.

1. *Coal Rock.*— This rock comes directly from the vegetable world. You already know that our vast coal beds are the remains of forests that, at the time of the flood, were buried in the earth. This transformation was caused by pressure upon the wood. Peat is a form of coal made in low, boggy, marsh land. This is made from the vegetation buried by water and soil.

2. *Agates and Opals.*— Some of these are wood turned to stone. You have perhaps seen in a museum specimens of petrified wood which plainly showed the grain of the wood and the rings of growth.

3. *Diatoms.*— These are small, one-celled plants shaped like a boat. They are too small to be seen by the naked eye. Each diatom has a hard, glassy skeleton; and when the plant dies, it decays, except the skeleton. This hard, transparent, glasslike substance is made of the same material as quartz. It can not be dissolved by any strong acid, neither will it melt when heated. When ponds and lakes dry up, the bottoms in some instances are found to be composed of the skeletons of diatoms many feet deep.

Now let us notice a few of the animals that help to make rocks:—

1. *Quartz.*— For a long time sponges were thought to belong to the plant kingdom, but now scientists regard them as animals. If a sponge is examined, it will be found to have a skeleton of spicules (spikes) consisting of the same material as quartz, like the diatoms. Not all sponges have a skeleton composed of quartz material, as some are made of limestone, or a horny substance. Hence, you see, the sponge helps to make both quartz and limestone rock when it dies.

2. *Limestone.*— Other animals that contribute their skeletons to limestone making besides the sponge, are the rhizopods, the corals, and the mollusks.

The rhizopods are very small. Many of them can not be seen without a microscope.

The corals also are small creatures, but large numbers live in different rooms in the same house. When they die, their rooms are left vacant, and their children build new rooms on top of the ones their parents occupied. When the whole colony die off because they have been raised above the water, they then leave the tower they have built to be an island home for man.

The mollusks that contribute to rock building are, clams, oysters, mussels, etc. Their skeletons drop to the bottom of the pond or lake, and mix with the mud. Should the lake or pond become dry, the remains at the bottom form into limestone rock. The skeletons of these mollusks may be seen in the rock.

Thus we see how the Creator, even under conditions caused by sin and the curse, has so arranged that there may be soil to provide man with food; for God put man in a garden "to dress it and to keep it."

Experiment

Take a piece of limestone or marble, and place on it two or three drops of hydrochloric acid. What happens? This is the test for limestone. Try the acid on quartz or other minerals.

Questions

1. Describe the scene witnessed by Elijah. 1 Kings 19: 11, 12.
2. What do some geologists think about the age of the earth? Why?
3. What would help them to form a different conclusion?
4. What did Peter say would arise in the last days? What would be their reasoning about the destruction of the earth? On what would their reasoning be based? How does Peter expose their false theories?
5. What extraordinary workings of God in the natural world can you mention? What are some of His ordinary ways of working?
6. In what ways does He break up and decompose the rocks?
7. Is God limited to these ordinary methods of breaking and decomposing the rocks?

8. What methods does He use for making rocks, in the mineral world? In the plant world? In the animal world?
9. Is He limited as to the time He must use to accomplish His purposes?
10. Why are geologists so insistent on making the days of the creation week long periods of time?
11. What is the only safe guide in matters of science as well as in religion?

Experiments with Minerals

What is the difference between a rock and a mineral? — A rock is a combination of several minerals, but usually not more than four. A mineral is a *definite chemical compound* existing in rock masses or alone.

Make a collection of rocks and minerals, and classify them according to the following outline: —

Kinds of Rock
1. Archæan.
2. Sedimentary — formed from sediment.
3. Igneous — heated and cooled.
4. Metamorphic — crystalline structure.
5. Chemical — chemically formed.
6. Æolian — deposited by wind.

Carbon and silicon unite with oxygen and some other element, forming a large number of compounds. Those minerals having carbon with oxygen and another element are called *carbonates.* Example: limestone, which has the three elements, carbon, oxygen, and calcium.

Those minerals having silicon and oxygen with another element are called *silicates.* Example: mica, which has the three elements, silicon, oxygen, and aluminum, and, in addition, some of the micas have potassium, magnesium, or iron, or some other element.

The carbonate and silicate minerals, or the rock containing them, can be more readily identified by the following experiments:—

1. Test your collection of stones by pouring a few drops of hydrochloric acid upon each. What takes place? Drop a small piece of limestone into a tablespoonful of hydrochloric acid or strong vinegar. Bubbling or *effervescence* of the acid, as it is called, is the test for limestone and all carbonates. Carbon dioxide is set free, and that causes the bubbles to form.

2. Place a tablespoonful of soda in a two-quart glass jar, and pour a little vinegar upon it. What happens? Lower a lighted candle into the jar. What takes place?

3. Weigh a piece of limestone carefully, and then heat it red-hot. After it cools, weigh it again, and compare weights. What causes the difference? What has been produced?

4. Wet some quicklime with water, and describe what takes place. What causes the heat? Can you think of another way of producing heat without fire?

5. Test clam and oyster shells, coral, or any other sea shells, with hydrochloric acid. Heat pieces of them to see if quicklime is produced. How was much of the limestone formed?

6. Silica stones, as quartz, flint, etc., can be distinguished from limestone by the peculiar odor given off when the stones are struck a hard blow with a hammer or another stone.

7. How do limestone and flint, or quartz, compare in hardness? Take a sharp steel point, or the point of your knife blade, and test your collection with reference to hardness. If you can make no impression, strike the stones together and see which is dented. If the sudden blow causes an odor like burnt powder, remember they are silicate stones. The hardest stone is the diamond. Gypsum is one of the softest stones. Make a list of your stones according to the degree of hardness.

8. Heat some soft stones red-hot, then moisten them and note what takes place. If gypsum is heated in a kiln, it gives off steam, and a dry, white powder is left, called plaster of Paris.

Stones

Ye also, as lively stones, are built up a spiritual house, an holy priesthood, to offer up spiritual sacrifices, acceptable to God. 1 Peter 2: 5.

Stones are fragments of rocks worn more or less smooth by the action of water, heat, and air.

Job was well acquainted with the breaking up of rocks, and the wearing away of the stones. He says: "Surely the mountain falling cometh to naught, and the rock is removed out of his place. The waters wear the stones: Thou washest away the things which grow out of the dust of the earth; and Thou destroyest the hope of man."

Stones vary greatly in size, shape, and color. Small stones are called *pebbles,* and a large bed of small stones is called a *gravel bed.* Sometimes a stone is made up of a large number of pebbles and gravel. It is then called a *conglomerate.* Some round stones are hollow, and have crystals formed on the inside. These are called *geodes,* because they are of the shape of the earth.

There is a class of stones that have very beautiful, brilliant colors. These are known as the *precious stones.* Everybody is more or less familiar with them. Do you know when they were made? Are they the result of heat and pressure on the rocks, or were they made when the earth was created? We find two of them, the onyx stone and bdellium, mentioned along with gold in Gen. 2: 12; therefore they were created when God made our world.

Do you think precious stones existed before the world was created? Again let us turn to the Book of books (which tells so many things we would never have known if we did not have it), and see if it will answer the question. In Eze. 28: 12-14, we read these words concerning a certain being: "Thou sealest up the sum, full of wisdom, and perfect in beauty. Thou hast been in Eden the garden of God; every precious stone was thy covering, the sardius [ruby], topaz, and the diamond, the beryl, the onyx, and the jasper, the sapphire, the emerald, and the carbuncle, and gold: the workmanship of thy tabrets and of thy pipes was prepared in thee in the day that thou wast created. Thou art the anointed cherub that covereth; and I have set thee so: thou wast upon the holy mountain of God; thou hast walked up and down in the midst of the stones of fire."

This is a description of Lucifer, adorned with precious stones, who also walked among the stones of fire on the mountain of God in heaven. Afterward he became self-exalted, and was cast out of that holy place. He then came down to this earth, and deprived Adam and Eve of their beautiful home in Eden. Thus we see that there were stones in heaven before the earth was created.

Satan was deprived of his covering of precious stones when he was cast out of heaven. After man had used the gold and precious stones to exalt himself, he also was almost wholly deprived of these treasures; for at the time of the flood they were buried in the earth, and much labor is required to obtain them.

Precious stones are very hard, and they are melted and dissolved with great difficulty.

When God arranged for the sanctuary service, he told Moses to have twelve precious stones placed upon the breastplate of the high priest. Upon these stones were to be engraved the names of the twelve tribes of Israel. These names being engraved in enduring stones signified the everlasting love of God for His people, and that they could never be erased from His mind. Through the prophet Isaiah the Lord says to His people, "Behold, I have graven thee upon the palms of My hands; thy walls are continually before Me."

When the earth is finally redeemed, there will be an abundance of precious stones. We do not need them to adorn our bodies here in this world of sin. If we had them, they would be a snare to us, and would cause us to feel proud and exalted. That is why God buried them out of sight.

The precious metals and stones will be used freely in the New Jerusalem, the capital city of the new earth. The wall of that city will have twelve foundations, and each foundation will be made of a precious stone. Then jasper will be used to rear upon this foundation the wall "great and high." This jasper stone will be clear as crystal.

To make the foundation still more beautiful, it will be garnished — ornamented — with all manner of precious stones. There will be twelve gates opening into the city, three on each side, and every gate will be made of a single pearl. All the gates will open into the streets that extend through the entire city for a distance of 375 miles, and each street is to be paved with pure gold. What a wonderfully beautiful city it will be! But the chief attraction will not be the precious stones, nor the gold, but the glorious King of kings.

Those whose minds are filled with the laying up of gold and silver, and who take pleasure in adorning themselves with costly ornaments, will not be subjects of the new earth kingdom. They would be so attracted by the garnished walls, the gates of pearl, and the golden streets, that they would slight the King.

We must learn here to prize the inward adorning of a meek and quiet spirit, which in the sight of God is of great price. No outward beauty will commend us to Him. When we have secured the gold of character, then a crown of gold will be placed on our heads, and a harp of gold in our hands. When we become living stones in God's spiritual temple by overcoming sin, then we shall receive "a white stone, and in the stone a new name written, which no man knoweth saving he that receiveth it."

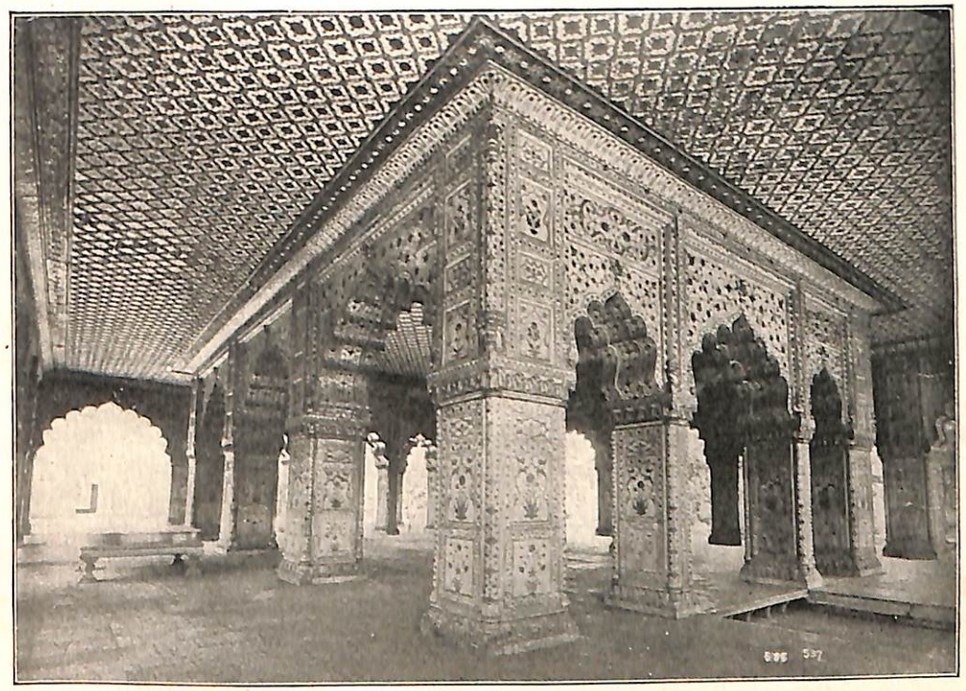
Questions

1. What is the difference between a rock and a stone?
2. Define a pebble. A gravel bed. What is a conglomerate? A geode?
3. What are precious stones? When and how were they made? Gen. 2:11, 12.
4. Are there precious stones in heaven? Give proof. Eze. 28:12-14.
5. Describe Lucifer's covering. How and when did he lose it?
6. What did God do with the precious stones on earth at the time of the flood? Why? Do we need them now?
7. What use was made of the precious stones in the tabernacle service? What did this signify?
8. Of what use will precious stones and metals be in the new earth?

9. Describe the foundation and wall of the capital city of the new earth. Describe its gates and streets. Rev. 21:10-21.
10. What will be given those who have secured the gold of character?
11. What will be given those who become living stones in God's spiritual temple?

Note Book Requirement

Name and describe, on page 41, the precious stones seen in the walls of the New Jerusalem.



PALACE AT DELHI, INDIA

Built of purest marble, with ceiling of silver, and with the most marvelous inlaid mosaic of all manner of precious stones. Its ancient magnificence must have been beyond description. Such magnificence but faintly represents the glory of the walls and buildings of the capital city of Revelation 21.

Observation of the Stars

A *constellation* is a group of stars. We will now describe and illustrate a few of the most interesting constellations. You should go out at night and locate these on the map of the sky.

Ursa Major and Cassiopeia are found not far from Polaris,— one on one side, and one on the other. Between them is Ursa Minor, swinging about the polestar, for Polaris is the end star of this constellation. *Draco,* the dragon, is a series of stars, whose body curves around between Ursa Major and Ursa Minor. These names mean *Big Bear* and *Little Bear,* and "Draco" means *Dragon.* As you will remember, the ancient Greeks and Romans named the constellations after imaginary people and creatures they saw in the sky.

Upon the star maps you can see how these constellations are located with reference to one another.

1. *The Summer Division of Constellations.*— Visible during the evenings of July and August.

We shall now see the Milky Way spanning the heavens like an arch. Arcturus is sinking in the west, while Cassiopeia is rising in the northeast. In the Milky Way, some distance above Cassiopeia, is *Cygnus,* the Swan. It has five stars arranged in the shape of a cross. In the southern celestial hemisphere is a still more beautiful group called the "Southern Cross," but it can be seen only by those living south of the Equator.

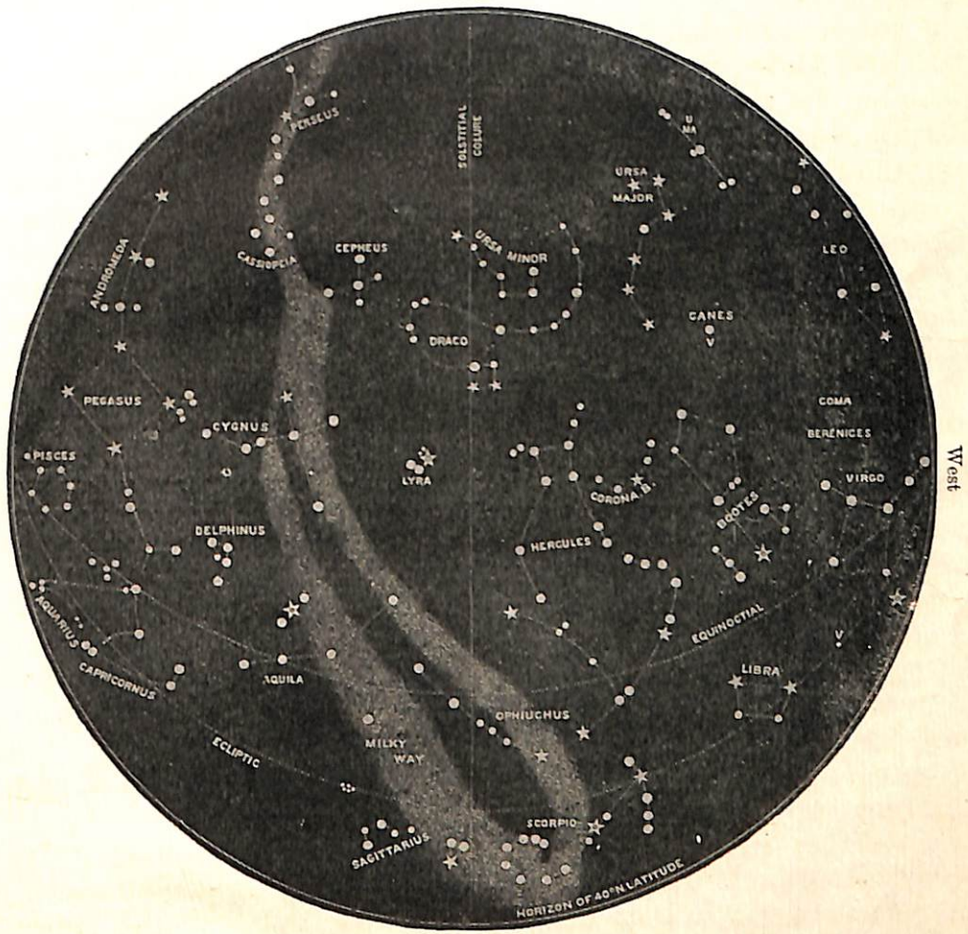
West of Cygnus is *Lyra,* the Harp, which has been described in Book 2.

South of Lyra, in the Milky Way, is *Aquila,* the Eagle. Its brightest star, *Altair,* is situated between two smaller stars.

Northeast of Aquila is *Delphinus,* the Dolphin, also called "Job's Coffin." Four of its principal stars form a figure resembling a diamond.

NOTE.— By inverting the four large maps and placing them over the head so that a straight line from your eye through Polaris on the map would point directly to Polaris in the heavens, you will find the stars on each map arranged as they are in the heavens at the time specified below.

North



East West

South

THE HEAVENS AS SEEN

JUNE 22 AT MIDNIGHT — AUGUST 7 AT NINE O'CLOCK
JULY 22 AT TEN O'CLOCK — AUGUST 23 AT EIGHT O'CLOCK

Scorpio, the Scorpion, is low down in the south, west of the meridian. Its brightest star, *Antares,* is red in color, and nearly of the first magnitude.

East of Scorpio is *Sagittarius,* the Archer.

2. *The Fall Division of Constellations.*— Visible during the evenings of October and November.

The Milky Way is now a little north of the zenith, and appears to be resting on the east and the west horizon.

Lyra is in the northwest, Aquila in the west. South of the zenith is the Square of Pegasus, formed by four bright stars. Three of these belong to *Pegasus,* the Flying Horse.

In the south, near the horizon, is the star *Fomalhaut,* belonging to the constellation *Piscis Australis,* the Southern Fish.

Taurus, with the Pleiades, is east of the zenith. *Castor, Pollux,* and *Procyon* are lower down. *Orion* will rise a little south of east; and after him will rise *Sirius,* king of the fixed stars.

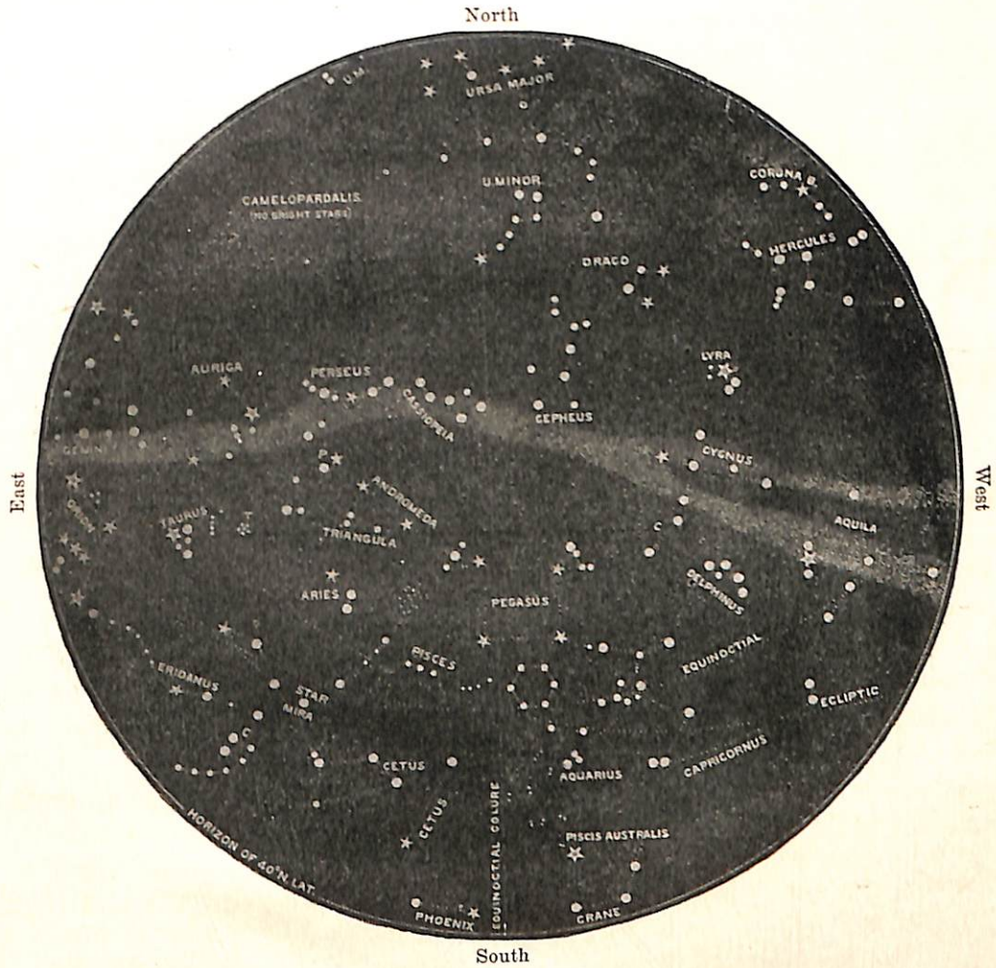
3. *Winter Division of Constellations.*— Visible in the evenings of January and February.

At this time of the year, you will see the Milky Way spanning the heavens, passing west of the zenith, over to the south. In its path in the northwest is the already familiar Cassiopeia. Above it is *Perseus,* which can be recognized by a row of stars running along the center of the Milky Way, one of which is of second magnitude and much brighter than the rest. In this constellation you will see a cloudy mass called the *cluster of Perseus.* With a good glass you can see the separate stars forming this cluster.

Above and south of Perseus is *Auriga,* the Charioteer. It has one star of the first magnitude, *Capella,* the Goat, which is west of the zenith. Below the Milky Way is the constellation *Taurus,* the Bull. In it is a red star, *Aldebaran,* sometimes called the *Bull's Eye.* It is at one end of a beautiful V-shaped group of stars, called the *Hyades.*

In the same constellation, a little to the northwest, is the star cluster the *Pleiades,* already described.

East from Taurus, on the other side of the Milky Way, and near the zenith, is the constellation *Gemini,* the Twins. The Twins are named *Castor* and *Pollux.* Paul sailed in a ship whose sign was Castor and Pollux.

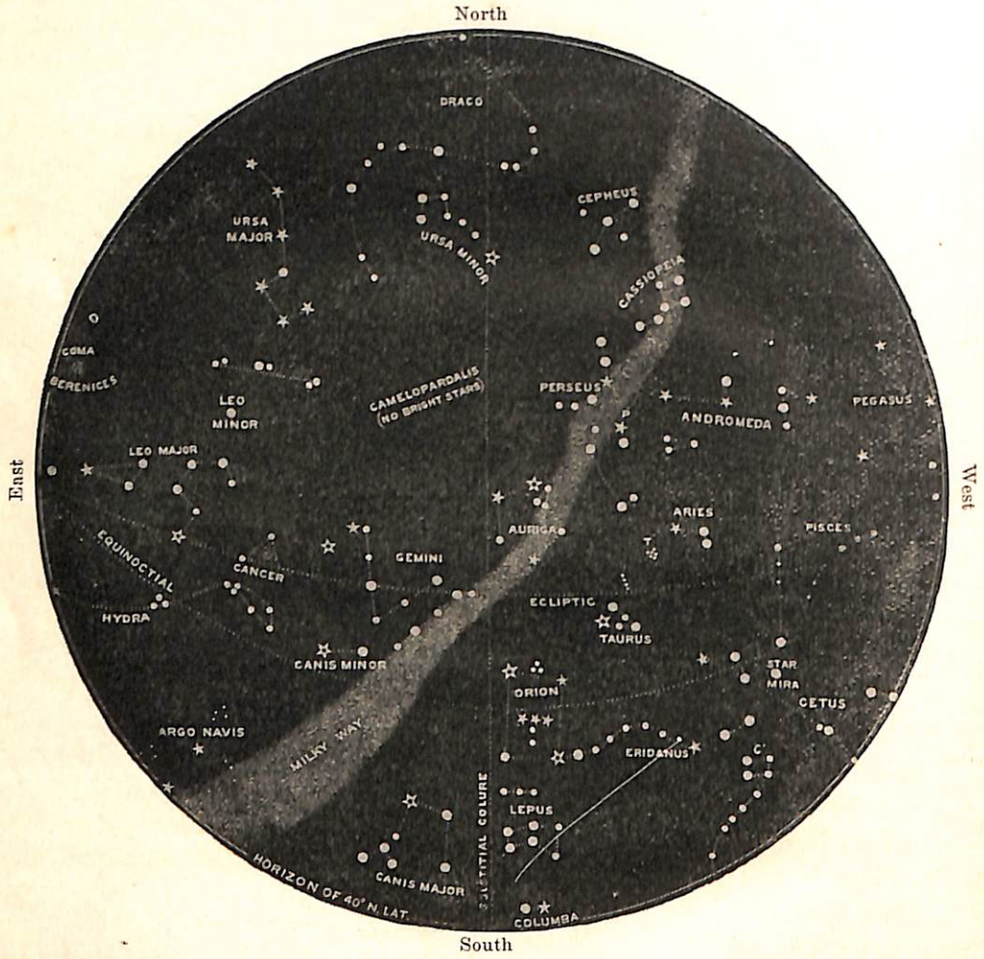


THE HEAVENS AS SEEN

SEPTEMBER 22 AT MIDNIGHT
OCTOBER 23 AT TEN O'CLOCK
NOVEMBER 7 AT NINE O'CLOCK
NOVEMBER 22 AT EIGHT O'CLOCK

Below these is *Canis Minor*, the Little Dog, which has a first magnitude star, *Procyon*.

Across the Milky Way lies *Orion*, the most beautiful and brilliant constellation in the heavens. This constellation, and



THE HEAVENS AS SEEN

DECEMBER 22 AT MIDNIGHT
JANUARY 20 AT TEN O'CLOCK
FEBRUARY 4 AT NINE O'CLOCK
FEBRUARY 19 AT EIGHT O'CLOCK

the star cluster Pleiades, are the only two groups of stars mentioned in the Bible. Orion contains two stars of first magnitude, *Betelgeuse* and *Rigel*. The former is a reddish star, and the latter is a bluish white. A row of three bright stars near the center of this constellation is called the "Band of Orion," and also the "Yardstick." Southeast of Orion, on the western border of the Milky Way, is Canis Major, the Great Dog, containing *Sirius*, the brightest fixed star in the heavens.

East of the Gemini is *Leo*, the Lion, which contains the bright star *Regulus*, which you will remember is near the celestial Equator, and at the end of a figure of stars forming a sickle.

4. *Spring Division of Constellations.*— Visible in the evenings of April and May.

The Milky Way is so near the horizon that it will be invisible. In the west can be seen the Twins, Castor and Pollux; but the constellations before noted west of the Milky Way have set or nearly so. Leo, just described, is a little west of the meridian.

A little east of the meridian is a bright star, as bright as Regulus, called *Spica*. It is in the constellation *Virgo*, the Virgin.

Quite near the zenith is *Coma Berenices*, the Hair of Berenice. This is a very large, thin cluster of faint stars, and is quite irregular in form.

East of this cluster is *Boötes*, the Herdsman. In this constellation is the brilliant reddish star *Arcturus*, mentioned in the book of Job. When Job was complaining against God, this question was addressed to him: "Canst thou guide Arcturus with his sons?" A very bright star is Arcturus; and it is here represented as a father, and the less brilliant stars that attend him across the heavens are spoken of as his sons. Job acknowledged that God made Arcturus, Orion, and the Pleiades.

In the northeast, below Arcturus, is *Corona Borealis*, the Northern Crown, a small but very beautiful coronet of stars that resembles a crown. The brightest star is of the second magnitude.

This gives you a general knowledge of the geography, or as the astronomers say, the *uranography*, of the celestial sphere. All these constellations and clusters of stars may be considered as continents and islands in the sea of the sky, and are located

THE HEAVENS AS SEEN

MARCH 21 AT MIDNIGHT
APRIL 20 AT TEN O'CLOCK
MAY 5 AT NINE O'CLOCK
MAY 21 AT EIGHT O'CLOCK

by astronomers by degree measurements, just as geographers locate the land divisions and the cities and towns. The large, bright stars might be compared to our large cities, and the smaller ones to towns and villages.

In the study of geography, we learn of countries and cities that can be visited; but in the study of uranography, we learn of places which I hope we may all visit some day not far away.

Zodiacal Constellations.— Before concluding the study of the constellations, let us learn which ones are found in the *zodiac*. The zodiac is a belt sixteen degrees wide, around the celestial sphere. It is so called because of the animals that the ancients thought they saw within the belt. This belt is the path in which the sun and the moon appear to travel in the heavens, and the constellations in this path are called the *zodiacal constellations*. There are twelve of them, and most of them we have already noticed.

The zodiacal belt is divided into twelve equal sections, or signs, as they are called, each sixteen degrees wide and thirty degrees long. The sun produces one season while passing through three sections, or signs; or the four seasons,— spring, summer, autumn, and winter,— while passing through the twelve signs, or constellations.

The diagram shown on page 212 will make plain how the earth, in revolving around the sun, makes it appear to travel through the twelve signs of the Zodiac. You will find the signs of the zodiac illustrated and explained in every almanac.

The sun enters a sign about the twenty-first day of each month. Spring begins when the sun crosses the celestial Equator at the vernal equinox, March twenty-first. At this time, the sun rises exactly in the east, and sets exactly in the west.

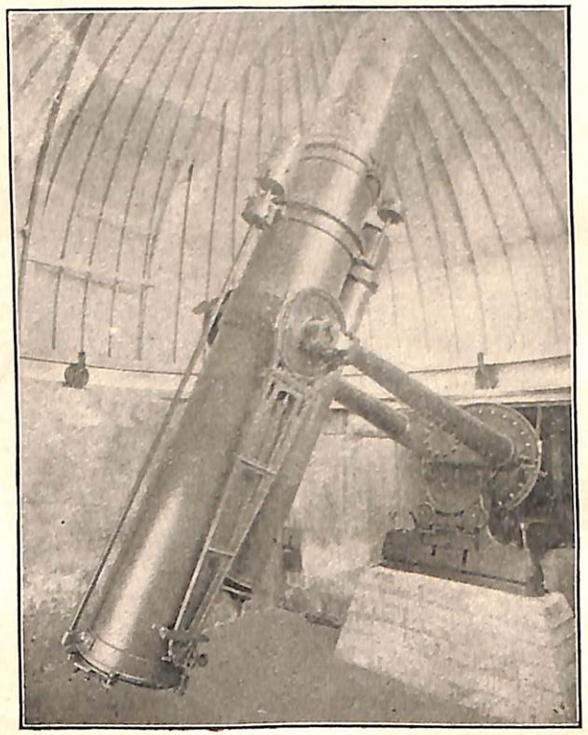
On the twenty-first day of June, the sun reaches the highest point in the heavens. This point is called the *summer solstice*. This brings the longest day of the year.

On September twenty-first, the sun crosses the celestial Equa-

tor again, and this point of crossing is called the *autumnal equinox.*

On December twenty-first, the sun reaches the lowest point south, and we have our shortest day. This point is called the *winter solstice.* Review lesson 65, "The Seasons," Book 2.

The Lord made the sun to produce the seasons, as we have already learned. In this lesson, we find that the sun apparently and the earth really bear a certain relation to the twelve signs. They are all brought into certain relations for each season. When Job doubted God's power, this question was asked him: "Canst thou bring forth Mazzaroth [the twelve signs] in his season?" We find several instances where Job's faith was strengthened by considering God's sustaining and guiding power in the heavens. We may learn lessons of faith and confidence from the same source.



Collecting and Rearing Insects

Below are given a few general suggestions as to methods that can be used in rearing and collecting insects. It will be necessary to vary these methods somewhat as you study the various species.

Rearing Facilities

1. Insectarium for land insects.

In collecting insects for study in confinement, their native home surroundings should be carefully noted, and as far as possible, should be copied. If the insects are feeding on plants, then some of the plants should be taken into their new home for their food. If they live in water, determine whether still or running water is their native element. If they are carnivorous, notice what they feed on. Many of this class will eat raw meat. Great pains should be taken not to injure the insects when collecting them. Those feeding on plants can be carried in tight boxes, in which should be placed some of their food. Air holes are not necessary. Aquatic insects can be collected in large bottles with wide mouths, or in glass fruit jars. If the bottles or jars are partly filled with water, they may be closed tightly during an ordinary field trip.

The following are a few of the many kinds of insectariums or breeding cages that may be provided: —

a. Fit a pane of glass into one side of an empty soap box. A board three or four inches wide should be placed below the glass, so that a layer of soil can be put in the bottom of the box. The pane of glass should be placed in grooves, to allow it to be moved up and down, and thus serve as a door.

b. In rearing caterpillars and other leaf-eating larvæ, branches of the food plant should be placed in bottles or cans in which is moist sand. If the sand is kept moist, the plants will remain fresh a longer time than if kept in water, and the danger of drowning the insects is avoided.

c. Many full-grown larvæ burrow into the ground to pass the pupa state; and on this account, a layer of loose soil should be kept in the bottom of the breeding cage. If the soil becomes too dry, the pupæ will not mature; if too wet, they are liable to mold or drown. Many insects pass the winter in the pupa state. These pupæ may be left in the breeding cage or packed away in moss, but the soil or moss must be kept moist. Cages or boxes containing pupæ should be stored in a cool place, as the cellar or an unheated room. They may be placed in a large box out of doors, but where the sun can not shine on them.

d. An excellent insectarium can be made with a flower pot and a lantern chimney. The food plant of the insects to be raised is planted in the pot, and a lantern chimney covered with Swiss muslin is placed over the plant. Sand may be put into a tin can or bottle, and kept moist, and the stems of food plants forced into the wet sand.

2. Aquarium for quiet water insects.

a. Imitate natural conditions as nearly as possible.

b. Almost any glass vessel will serve as an aquarium. Tumblers, battery jars, and fruit and candy jars are useful.

c. Put a layer of sand about one inch deep in the bottom of the vessel used.

d. Fill with pond or stream water to within about three inches of the top.

e. Put into the vessel some of the water plants found growing in the native homes of the insects.

f. Put into the vessel a few stems, letting them extend out of the water. These will serve as supports for the larvæ to crawl out upon.

g. Cover with fine wire netting, or with a piece of mosquito netting or Swiss muslin held in place by a rubber band.

h. Place in a north window if possible. Avoid placing in direct sunlight.

i. Put only a few insects into each jar. Let these be of the same kind, and about the same size.

j. Avoid overheating the water. Keep rather cool.

k. Replace the evaporated water with pond or stream water. Do not use hard water. Change the water if a foul odor is present or a film appears on the water.

l. Supply suitable food for the insects.

3. Aquarium for insects living in running water.

Take an old, worn-out cane-bottomed chair, and cover the legs with fine wire screening. Make a hinge screen lid to cover the cane-bottom opening, so that insect forms may be readily removed from the screened cage. A similar screen cage can be made by sawing a banana crate in two about the middle of its length. After the cage is finished, it can be placed at any point in the running stream over desired insects or other animal forms. If the cage is pushed down into the mud, the larvæ, nymphs, and other forms of water insects can not escape.

Collecting Facilities

1. A land net.
2. A water net.
3. Tight tin boxes for living specimens.
4. Quart jars, with tops, for living specimens.
5. A common garden rake.

Construction of Apparatus

1. *Land Net.*— Secure from a hardware store four or five feet of No. 12 spring brass wire. Bend it into a round loop about one foot in diameter, crossing the wire six inches from the ends, and giving it one firm twist. Now wind the six inches of the free ends of the wire around a small iron rod or stick, thus making a spiral form into which a stick can be screwed for a handle. The net may be made from three quarters of a yard of cotton tulle or light cheesecloth sewed into a bag, rounded at the bottom, and just as large as the frame at the top. It will be more durable if a narrow border of sheeting is stretched around the top to cover the wire. The bag should be a little over twice as deep as it is wide.

2. *Water Net.*— This net should be strongly made. It should be of equal width and depth, and made of a fine-meshed bobbinet attached to a ring by means of strong muslin. The ring should be made of fourth-inch iron rod bent in the form of a semicircle, and firmly fastened to a long handle. The handle should be attached to the middle of the curved side of the ring.

How to Use the Nets

1. The land net will not be difficult to use, and it will furnish good exercise for boys and girls in catching flying insects. The eye and the hand will receive training at the same time.

2. The water net is a little more difficult to handle. After placing the net down in the water, move it along, with its mouth open in the direction of the motion. This movement is called *sweeping*. There should be sweeping on the surface and under the surface. Sweep also among the submerged or partly submerged water plants on the bottom, so as to get the insects that are found in all these different places.

3. On bringing up a net load of material from a sweeping of the bottom, wash out as much of the dirt and trash as possible, by scooping the clear water with the net and letting it drain through. This makes easier the examination of the catch, especially some of the dark-colored forms that are difficult to see in the muddy contents of the net.

4. Rinse out the net thoroughly before leaving the collecting place, and on reaching home put it in a place where it will soon dry.

5. When collecting in a stream where there is a current, work upstream, in order that the muddy water may not interfere with collecting.

How to Use the Rake

1. Use the garden rake in ponds and streams where there is much loose material on the bottom.

2. Rake a mass of this material ashore and examine it. The insects will show themselves in trying to get to the water.

1 Cerebrum: reason & controls voluntary muscles

2 Cerebellum: helps cerebrum and controls actions.

3 Medulla: regulates internal organs

4 Spinal cord: reflex actions

why we eat

Growth — Protein growth

Heat — starch sugar } Heat energy

energy — fats oils } Heat energy

DEMCO CRYSTALJAC
IN. GUARDIAN